

# Exploration of High-Quality Development of Kindergarten Science Education in the Age of Metaverse

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**Abstract:** Technology drives the progress and development of human society, and the emergence of metaverse is the result of the joint action of many modern technologies. The arrival of the metaverse era provides a driving force for the high-quality development of kindergarten science education. In the future, the scene of science education will move towards the integration of reality and reality, the way of science education will be more flexible and diversified, the selection of science education content will be more scientific and comprehensive, science education resources will be integrated in many ways, science education evaluation will be more objective and efficient, and the quality of the science education teacher team will be effectively improved. Based on this, kindergarten science education in the era of metaverse will create a real-time interactive science education environment that integrates reality and reality, build a science education teacher team with the synergistic development of humans and machines, and create a science education evaluation system with the data of the whole process, which will stimulate young children's interest in science, enrich their experience in science, and develop their scientific emotions, and allow them to acquire scientific concepts, deepen scientific knowledge, improve scientific skills, and promote the development of science skills in the process of hands-on manipulation and problem solving. In this way, we can stimulate young children's interest in science, enrich their scientific experience, develop their scientific emotions, enable them to acquire scientific concepts, deepen their scientific knowledge and improve their scientific skills in the process of hands-on operation and problem solving, promote their all-round growth, and push forward the high-quality development of kindergarten science education.

**Keywords:** Metaverse; Kindergarten; Science Education; High-Quality.

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## 1. The Connotation of Metaverse and its Implications for Education

The term metaverse first appeared in Neal Stephenson's science fiction book *Snow Crash* until 2021 when the concept was reintroduced and warmly discussed. Currently there is no unified definition of metaverse, but the most representative definition among many views considers metaverse as a virtual space parallel to but independent of the real world, an online virtual world that maps the real world, and a digital virtual world that is becoming increasingly real [1]. The metaverse will profoundly influence and change human society, and it will reconstruct the new field of human existence in space and time, form the new way of human social life, and shape the new characteristics of human thoughts and behaviors[2].

### 1.1. Connotation of Metaverse

The rise and development of metaverse will also have a profound and non-negligible impact on the field of education. According to Liu Yongmou, metaverse discourse can be divided into four kinds, i.e., the "four arts of metaverse", which are: metaverse technology, metaverse art, metaverse discourse, and metaverse academics[3]. This paper focuses on metaverse academics, i.e., discussing the changes that the metaverse has brought to education, and furthermore, it mainly discusses how kindergarten science education in the era of the metaverse can achieve high-quality development. Before exploring this issue, it is necessary to clarify the connotation of metaverse. "Metaverse, as a vertical application of metaverse in the field of education"[4], is "a virtual-reality fusion educational environment shaped by emerging information technology, and a higher-order form of

intelligent educational environment in which the virtual and the real are comprehensively intertwined, the human and the machine are comprehensively connected, and the school and the society are comprehensively interacting." [5]. At present, "the meta-universe is at its inception stage, with the practical implications of comprehensive human education, social orientation and the future, with a view to reshaping the shape of education, promoting equity and justice in education, and leading the way in improving the quality and efficiency of education" [6].

### 1.2. Impact of the Metaverse on Education

The emergence of the metaverse will have a profound impact on the entire education system from basic education to higher education, and education will move towards digitalization until a complete digital transformation is achieved. "The metaverse can promote the reshaping of the teaching environment, the aggregation of teaching resources, the transformation of teaching methods, the change of teacher-student relationship, and the updating of teachers' professional norms" [7], and the metaverse will bring unprecedented impacts on the educators, the educated, and the educational impacts, i.e. the three elements of education. Teachers in the era of metaverse need to rethink the connotation of education in the context of the new era, adjust the education and teaching methods at the right time, and reasonably use the new technology to better adapt to the new needs of the society for talent cultivation under the development of the times; educated people's learning methods, learning space, etc. will undergo unprecedented and profound changes to get the whole body and mind immersive learning experience with the support of various technologies; and for

the educational impact, the content of education in the future will follow the development of the times to add cutting-edge knowledge, and the means of education will also achieve digital transformation.

## **2. Importance of Kindergarten Science Education in the Era of Metaverse**

As one of the five major fields in kindergarten, the importance of science education is self-evident. In the future, with the development of technology, the progress of society and the arrival of the metaverse era, kindergarten science education is even more responsible for promoting the comprehensive development of young children and advancing the human society.

### **2.1. The Needs of Young Children's Growth**

"Kindergarten science education activities shoulder the dual mission of scientific enlightenment for young children and promoting the growth of young children's whole life"[8], it is a kind of educational activity that guides young children to experience the process of scientific inquiry and construct their own scientific knowledge[9], it builds a bridge between scientific concepts and young children's existing experience, and it provides young children with the opportunity to share with their peers their opportunities for young children to share their personal experiences and ideas with their peers[9]. Kindergarten science education satisfies children's curiosity and desire to explore, and promotes the stimulation of children's interest in science, the accumulation of scientific experience, the construction of scientific concepts, the development of scientific skills, and the emergence of scientific emotions.

### **2.2. The Needs of Social Development**

"Science education is the education to cultivate scientific and technological talents and improve national literacy and is an important part of education."[10] And pre-school education, as the foundation stage of the whole education, is even more responsible for the cultivation of talents. In the era of metaverse, the development and iterative upgrading of technology makes the society and the whole world change and develop at an unprecedented speed. High-quality kindergarten science education in the era of the metaverse helps young children to better adapt to the ever-changing society, and at the same time, early scientific enlightenment helps young children to accumulate scientific experience, perceive scientific concepts, understand scientific knowledge, master scientific investigation skills and eventually develop scientific emotions, which will prompt them to better devote themselves to the construction of the motherland and the world in the future, better promote the development of hardware and software in the era of the metaverse, and ultimately improve the quality of human life and promote the development of human society.

## **3. Impact of the Metaverse on Kindergarten Science Education**

With the advent of the metaverse era, education will enter a new stage of development. The metaverse will have a profound impact on the teaching scene, teaching method, educational content, teaching resources, educational evaluation, and teachers of kindergarten science education.

### **3.1. Construction of Science Education Scenarios**

The cognitive development of children aged 3-6 is still in the pre-operational stage, and their thinking is characterized by concrete images, and they rely more on concrete things or scenes when they think. Diversified scenarios in science education activities provide opportunities and places for children to learn in real-life situations and scenarios.

Firstly, learning in real problem situations. With the development of video games, digital twins, artificial intelligence and other technologies, teachers can build rich, diverse, authentic, and hierarchical scenarios for young children to carry out scientific activities in the metaverse according to the needs of teaching and learning activities, in which young children can enter anytime and anywhere in a virtual avatar way, and participate in scientific inquiry activities wholeheartedly, multisensory, and in an immersive way. In the scientific activity scenarios created by teachers with purpose and plan, children discover problems, analyze them, and try to solve them, gain direct perception of abstract scientific knowledge and concepts, accumulate scientific experience, and lay the foundation for systematic and in-depth scientific learning in the future.

Secondly, learning in life scenes. The content of early childhood science learning should originate from young children's life, be close to their life, and eventually return to their life. In the era of metaverse, teachers can, with the aid of big data, Internet of Things, digital twins and other technologies, gain a deeper understanding of young children's living environment and grasp young children's existing life experience, so as to make the creation of science education scenarios in the metaverse closer to the real life of young children. In real life scenes, children observe scientific phenomena, discover scientific problems, accumulate scientific experience, feel the fun and usefulness of science through personal participation, hands-on operation and problem solving, and appreciate the importance of science to the development of human society.

### **3.2. Changes in Science Education Method**

Firstly, the frequency of kindergarten science activities is relatively low compared with other activities, and it is mainly carried out in the form of collective teaching activities, and the penetration of science education in corner activities, game activities and transition links are weak, so science education is not really carried out throughout the day of young children. On the one hand, in the era of metaverse, with the help of Internet of Things, human-computer interaction, big data, brain-computer interface and other modern technologies, teachers can obtain the thinking and behavioral data of young children, so as to better capture the opportunities of science education in daily life. Science education is no longer too focused on collective teaching activities, but permeates the corner activities, game activities, life activities. It better reflects the concept of discovering and solving real problems in science education.

Secondly, in current kindergarten science education activities, teachers explain and demonstrate more, leaving relatively little time for children to observe and experiment, and kindergartens provide fewer or even no opportunities for children to investigate and measure in the field, considering factors such as time and safety when carrying out science activities. With the arrival of the metaverse era, teachers and

children can digitally enter the metaverse, and children are able to discover real problems through observation and analysis in the "real" scientific inquiry scenes presented in the metaverse, and conduct experiments and investigations to verify their own ideas after thinking and discussing them, and then finally, after the children have summarized the results, the teacher makes a brief summary and comments on the children's scientific activities. If necessary, the scientific principles can be explained in a way that is acceptable to the children, considering their physical and mental development, age characteristics and interests. Under this approach to science education, children's autonomy and motivation are greatly stimulated, and the value of science education is better realized.

### **3.3. Selection of the Content of Science Education**

Appropriate selection of the content of kindergarten science education is of great significance to improve the enthusiasm of young children and promote their all-round development, but at present, there are problems such as blindness, arbitrariness, and imbalance in the selection of the content of kindergarten science education. With the advent of the metaverse era, the selection of science education content is more scientific, rational, and planned, and modern science and technology content is also penetrated into it.

Firstly, in the era of the metaverse, with the development of brain science and the development and maturity of brain-computer interface technology, human-computer interaction technology and Internet of Things technology, teachers will be able to intuitively understand young children's existing experience, their current level of development, their points of interest and their potential development space. At this time, teachers will have reliable reference information when designing science education activity programmes, so that they can design activity programmes that fit children's real life, meet children's age characteristics and cognitive development level, and satisfy children's interests and needs. Teachers will be able to shift from selecting science education content blindly and arbitrarily to selecting it in a planned and evidence-based manner.

Secondly, in the era of the metaverse, as the accuracy, objectivity and timeliness of teachers' educational assessment increase and the quality of the teaching force improves, teachers will shift their choice of science education content from emphasizing the transmission of scientific knowledge to taking into account the concern for and the cultivation of their scientific inquiry skills; and from emphasizing knowledge of the material sciences to taking into account knowledge of the life sciences and the space sciences. The imbalance in the selection of science education content has been reduced.

Thirdly, in the era of metaverse, the iteration and upgrading of science and technology is more rapid than ever, and as young children are in the midst of a fast-changing world, teachers have the responsibility and obligation to help young children to understand the development and application of science and technology through kindergarten science education, and to help young children to understand the impact of science and technology on their lives.

### **3.4. Enrichment of Science Education Resources**

Abundant kindergarten science education resources play a role in promoting the high quality of science education

activities, and the advent of the metaverse era has greatly enriched the material resources, curriculum resources and social resources needed for kindergartens to carry out science education activities.

First, material resources. The core of kindergarten science education activities lies in exploration, and the selection and use of materials in the process of exploration directly affects the quality of science education activities. In the metaverse, the problem of lack of material resources is fundamentally solved. The lack of experimental materials is no longer a factor affecting teachers' science education activities, and teachers and children can use any materials they need in the meta-universe to carry out scientific exploration activities.

Second, curriculum resources. There is still much room for improvement in the level and ability of teachers to organize and implement science education activities in kindergartens, due to the lack of teachers' scientific literacy, the fact that kindergartens seldom organize relevant teaching and research activities, and the high cost of relevant training for kindergartens and education management departments. This leads to the phenomenon of uniformity in the current science education activities in kindergartens. In the era of metaverse, all kinds of resources are integrated and readily available, so teachers can obtain the resources related to science education they need at any time, and in the process of learning, improve their own scientific literacy and ability and level of carrying out science education activities. In addition, teachers can observe how experts and scholars in the field of early childhood science education carry out kindergarten science education activities and communicate with them face-to-face in the metaverse at a close distance and at a low cost.

Third, social resources. The core of science education is exploration, which focuses on the observation of phenomena in life and the analysis of real problems. Currently, science education in kindergarten is mostly designed by teachers themselves and seldom goes out of the kindergarten or even out of the classroom, and the science education activities confined in the classroom fail to give full play to its role in promoting the development of young children in all aspects as it should be. In the future, parents can enter the metaverse no matter where they are and make use of their professional advantages to bring scientific knowledge to young children; teachers can lead young children into various communities through the meta-universe to safely and conveniently help young children to understand their own place of living and lay a good pre-experience for science learning; teachers and young children can visit science and technology halls and museums all over the world and conduct field investigations at any time in the metaverse. carry out field investigations, etc. Social resources have been better mobilized, injecting new vitality and vigor into the development of kindergarten science education activities.

### **3.5. Improvement of Science Education Evaluation**

Timely, objective, comprehensive and effective evaluation will promote the quality of educational and teaching activities, the comprehensive development of young children's body and mind, and the improvement of teachers' ability and level. With the arrival of the metaverse era, more evaluation subjects will participate in the evaluation of kindergarten science education activities, and the evaluation methods will develop in the direction of diversification, while the evaluation content is becoming more and more perfect.

Firstly, the pluralism of the evaluation subject. At present, science education in kindergarten is mainly carried out in the form of collective teaching activities, and the evaluation of science education activities is usually carried out at the end of the activities, generally by the teacher on the children's performance in the whole activity and whether the children ultimately gained the appropriate knowledge and skills to evaluate, mainly related to the evaluation of the child's development, and the evaluation of the curriculum, the evaluation of the environment and so on is in the absence of daily educational activities, which leads to the evaluation of the single subject. Parents, the rest of teachers, kindergarten leadership, and educational supervisory authorities are not fully involved in the evaluation of kindergarten science activities. With the advent of the metaverse era, the whole process of kindergarten science activities will be recorded and can be shared among parents, teachers, kindergarten directors and education supervisory departments, and different subjects can participate in the evaluation of the activities through the metaverse, and the subject of evaluation of kindergarten science education activities shows a diversified development trend.

Secondly, the implementation of evaluation content. According to the different evaluation objects, the evaluation content can be divided into curriculum evaluation, child development evaluation, environment evaluation and teacher evaluation. In the era of metaverse, the boundaries between the real and imaginary worlds are gradually blurred, and teachers, children, parents, kindergarten management, and education supervisory authorities can freely travel between the metaverse and the physical world. With the support of technologies such as big data, Internet of Things, and digital twins, the science education activities carried out by teachers at any time will be recorded in their entirety. Based on this, all dimensions of evaluation content will be better implemented. Firstly, in terms of curriculum evaluation, different evaluation subjects can go back to the past at any time and watch the process of teachers' science education activities in an immersive way, so as to analyze whether the objectives of science education are reasonable, whether the contents are appropriate and whether the implementation is effective, and to make an overall evaluation of the whole-time process of science education. Secondly, in the evaluation of children's development, it was carried out according to the three-dimensional objectives in terms of knowledge, skills, and affective attitudes. The two aspects of the mastery of scientific knowledge and the emergence of scientific emotion in young children are more implicit compared to the acquisition of skills, and it is slightly difficult for teachers and various evaluation subjects to carry out the evaluation. With the arrival of the metaverse era and the development and maturity of brain-computer interface, human-computer interaction and other technologies, the mastery of young children's scientific knowledge and the emergence of young children's scientific emotions will be presented in a visual and data-driven way in front of the teachers and the evaluation subjects, and the evaluation of young children's development will be more scientific, objective, and accurate. Again, in the aspect of environment evaluation, especially in the evaluation of psychological environment will be further implemented on the basis of the present with the arrival of the metaverse era. Psychological environment refers to the synthesis of all the information that the subject, i.e., the young children, can receive that can have an effect on their psychology, and a good

psychological environment is one of the necessary conditions for young children's scientific learning [11]. In the era of metaverse, teachers are able to monitor the psychological state of young children dynamically and in real time, and intelligently assess the psychological environment of young children's science learning in four aspects, namely, safety, tolerance, supportiveness, and the presence of good interpersonal interactions[11], to provide teachers with guidance on the creation of the environment. Finally, in the evaluation of teachers, it is divided into two types: teachers' self-assessment and other assessment. Teachers in the metaverse era can go back to the past to watch the whole process of conducting science education activities by themselves as bystanders in an immersive way, so as to find out the deficiencies in their education and teaching process from a third perspective. In the case of other evaluation, early childhood educators from different schools and levels can break through the limitations of space and sit together to discuss and evaluate a certain science education activity, so that teachers can listen to different experts and scholars to improve their own activities.

Third, the formulation of evaluation programmes. Evaluation programme guides teachers' evaluation behavior, currently in the evaluation of kindergarten science education activities, teachers only evaluate the phenomena observed during the activity and the performance of children at the end of the activity and face the whole class of children teachers use the same set of evaluation mode. As a result, the evaluation of kindergarten science education activities has a single standard, lack of relevance and other problems. With the arrival of the metaverse era, with the support of artificial intelligence, big data, digital twins and other technologies, the evaluation of science education activities will be more personalized and targeted, and teachers can conduct more accurate and effective evaluation of young children according to their learning data, in order to maximize the evaluation of the role of promoting the development of young children. The role of evaluation in promoting children's development will be maximized.

### **3.6. Construction of Science Education Teachers' Team**

The high-quality development of preschool education not only needs the investment of funds and the construction of curriculum system, but also needs a professional, dedicated and happy teacher team, and the kindergarten teacher team is the key force to promote the high-quality development of preschool education [12]. With the advent of the metaverse era, teachers will have more opportunities and time to learn and improve, thus accelerating the construction of the kindergarten science education teacher team, which will in turn promote the high-quality development of kindergarten science education.

For one thing, the opportunities for teachers to learn and improve have increased. On the one hand, the boundary between the physical world and the virtual world disappears in the era of metaverse, and teachers can travel freely between the two worlds. Teachers can observe the science education activities of teachers who have made great achievements in the field of kindergarten science education around the world, and they can communicate with them from a distance. In the process of observation and learning and mutual exchange, they can reflect on their own teaching problems and improve their own level and ability to carry out science activities. On

the other hand, in the era of metaverse, thanks to the development of blockchain, big data, network and computing technologies, learning resources are shared globally, so that teachers can obtain the learning and teaching resources they need at any time to improve their scientific literacy and science education level.

For another thing, the time for teachers to learn and improve will increase. Firstly, some repetitive and mechanical non-teaching work will be handed over to machines, and teachers will have more time to focus on their teaching work. Secondly, in the era of metaverse, teachers are no longer alone, robot teachers and virtual teachers will assist teachers to complete their teaching work and reduce their teaching burden. Finally, AI can answer some of the queries of young children and parents to a certain extent, and teachers will be liberated from tedious responses to questions. Combining the above three aspects, compared with the present time, teachers in the era of metaverse will have more free time at their disposal, which teachers can use to improve their own quality and ability.

#### **4. Ideal Patterns of High-Quality Development of Kindergarten Science Education in the Era of the Metaverse**

With the rapid development of modern technology, the importance and urgency of science education is becoming more and more prominent. Kindergarten education, as an important part of basic education, shoulders the important responsibility of laying the foundation for the development of young children's whole life, and it should pay more attention to the development of science education activities, and continuously improve the quality and level of kindergarten science education. Metaverse provides corresponding support for the change of teachers' concepts, the breakthrough of education and teaching time and space, the immersive learning experience of young children, and provides data support for the whole process of science education. Constructing an ideal model of kindergarten science education in the era of metaverse is not only beneficial for kindergartens and teachers to reflect on the current problems of kindergarten science education, but also for the long-term development of kindergartens and kindergarten science education.

##### **4.1. Creating a Real-Time Interactive Science Education Environment That Integrates Reality and Fiction**

###### **4.1.1. Satisfy Young Children's Curiosity and Stimulate Their Interest in Science Through Real-Life Experiences**

Due to the characteristics of young children's thinking and cognitive development, learning in the early childhood stage relies heavily on direct perception and experience, and young children's senses are an important medium for them to understand the world in the early stage of their lives. As one of the five major areas of science in kindergarten, its own uniqueness requires teachers to pay attention to children's interests in their daily lives and create corresponding environments for them to perceive and experience; it also requires teachers to pay attention to children's direct perception and real experience of the materials and environments in the process of carrying out the interaction of

kindergarten science education. The children get real experience through personal perception, feel the charm of science in the experience, and then activate their interest in science.

The emergence of the metaverse brings an unprecedented sense of presence and immersion to young children, creating a rich, diverse, safe, child-friendly, real-time online virtual activity space for them to play, perceive and experience. No matter where they are, as long as there is a need, young children can enter this real-time online virtual activity space with the assistance of brain-computer interface and other technologies in the form of a digital body, observing all kinds of scientific phenomena and all kinds of scientific experiments in a zero-distance, whole-hearted and immersive way, and even taking the form of materials in the scientific experiments and participating in the experimental process in a real way. In the course of observation and experience, under the guidance and help of teachers and virtual teachers who also enter the space virtually, they gain the initial perception of scientific phenomena and science itself, and satisfy their curiosity while stimulating their interest in further learning science.

###### **4.1.2. Young Children Accumulate Scientific Experience and Construct Scientific Concepts in Independent Exploration**

"Young children's science learning is an active construction based on personal experience" [9], "Science education should begin with experience, go through experience, and ultimately end up in experience." [9] Young children's science experience is mainly acquired through multiple senses such as sight, hearing, touch, taste and smell in the process of young children's personal participation, hands-on operation and independent exploration. It includes both the process and the result of young children's science learning. Young children's understanding and mastery of scientific concepts is a long process, and even throughout the early childhood stage, they can not really understand those abstract scientific concepts [9]. And science education builds a bridge between young children's existing experience and scientific concepts [9], and the new images and experiences that young children acquire in the process of observing scientific phenomena, participating in scientific activities, and communicating and discussing with others help them rethink and construct their own scientific concepts.

Kindergarten science education activities are the main way for young children to acquire scientific experience, and the accumulation of scientific experience and the construction of scientific concepts of young children in the era of the metaverse are supported in many ways. One of them is the construction of independent exploration scene. Teachers in the era of metaverse can create real problem situations or daily life scenes for children in the metaverse according to the needs of teaching and learning, and children do not need to imagine the scenes in their minds according to the teacher's explanations or thin demonstrations, but can immerse themselves in them wholeheartedly and carry out exploratory activities under the guidance of the teacher. Second, the provision of independent exploration materials. In the virtual space of the metaverse, the materials needed to conduct scientific experiments are greatly enriched, and children can enter it at any time to use these materials to conduct scientific exploration activities. The construction of the independent exploration scene and the provision of materials give children the opportunity to gain new experiences in interaction with

concrete things and phenomena and in actual operation, and scientific experience is the important basis for their construction of scientific concepts.

#### **4.1.3. Young Children Develop Scientific Enquiry Skills Through Hands-On Participation and Manipulation**

The core of scientific activities lies in inquiry, and the cultivation of scientific inquiry skills in young children is one of the important links in science education. Early childhood scientific inquiry skills mainly include "asking questions, observing, describing, collecting evidence and drawing conclusions" [9]. In the current kindergarten science education activities, due to the lack of opportunities for children's participation and the limitation of activity time, children's scientific inquiry skills have not been developed to the extent they deserve.

In the era of the metaverse and the construction of virtual science education activity scenarios, young children will have ample opportunities and time to really participate in science activities and develop scientific inquiry skills in hands-on operations. At this time, young children become the main body of science activities rather than the bystanders of the teacher's demonstration or operation. In the era of metaverse, children are able to carry out all kinds of scientific inquiry activities independently under the premise of ensuring safety. Under the guidance of scientific interest and on the basis of scientific experience, they raise questions in different scientific scenarios created by the teacher and draw final conclusions through the processes of observation, analysis and experimentation. In the era of metaverse, the interaction between young children and the activity materials, with the environment, with their peers, and with the teacher is enhanced, and in this process, young children participate wholeheartedly, and through the whole activity, young children's inquiry skills in various aspects are exercised and improved.

#### **4.1.4. Young Children's Holistic and Harmonious Development Through a Wide Variety of Activities**

The current kindergarten science education lacks the real participation and practical exploration of young children, and is more often carried out in the form of explanation and demonstration by teachers, observation, imitation and simple operation by young children. Throughout the science education activities, children's physical participation is less and more of a thinking activity. Teachers ultimately hope that children can understand certain scientific principles and speak certain scientific truths. The whole science education activity emphasizes the training of young children's minds, while neglecting the role of young children's bodies in the whole science activity. Under such a background, young children are not able to achieve the expected comprehensive and harmonious development of body and mind through science activities.

In the era of metaverse, with the construction of science education scenarios based on real problem situations or life scenarios; the selection of scientific, reasonable and comprehensive science education contents; and the rich integration of material, curriculum and social resources for science education, young children are able to participate in a variety of science activities in a multi-sensory, whole-body, whole-mind, and immersive way, and the position of young children's bodies in science activities has been brought back to the forefront. Therefore, through kindergarten science education activities, not only do young children's minds get

exercised, but the functions of all parts of their bodies are also improved.

In addition, the rich and varied kindergarten science education activities promote not only the development of the scientific aspects of young children, but also the overall development of young children in all dimensions. For one thing, the development of all dimensions of science for young children. In the era of metaverse, young children sprout scientific interest, accumulate scientific experience and develop scientific skills in real scenes, in active interactions, and in immersive experiences and perceptions. Both scientific knowledge, scientific method and scientific attitude have been exercised and improved to different degrees. Secondly, the development of young children in various aspects. For example, in the process of scientific activities, young children inevitably need to communicate and cooperate with others. In the era of metaverse, the scope of such mutual cooperation and communication is further expanded, and young children can not only cooperate and communicate with young children in their own classes and kindergartens, but also enter into the virtual space of metaverse to carry out scientific exploration activities with people all over the world, thus realizing the cooperation and communication across ages, regions and nationalities. This promotes the development of young children's communication skills, coordination skills, co-operation skills, etc. while enhancing their scientific literacy, expanding their horizons, and enriching their knowledge. Thirdly, the future development of young children. Early science learning lays the foundation for young children's later science learning, and the knowledge, experience and skills acquired in science activities also pave the way for their learning of other subjects and later life.

## **4.2. Building a Science Education Teaching Force with Human-Computer Synergy**

The quality of kindergarten science education teachers has a direct impact on the quality of kindergarten science education. Currently, there are fewer teachers in the kindergarten teaching staff who know a lot about kindergarten science education, and many of them are from an arts background, and their knowledge of physics, chemistry and other phenomena is not deep enough, which will, to a certain extent, affect the high quality of kindergarten science education activities. Furthermore, in addition to their normal duties of leading classes and preparing lessons, kindergarten teachers also have to take on many trivial and complicated tasks such as creating environments, arranging materials, and communicating with their families, all of which will divert the teachers' energy and increase their workload, and then they will have limited time to study how to carry out science education activities with high quality.

In the era of the metaverse, a science education teaching force will be formed with the synergistic development of human teachers, robot teachers and virtual digital teachers, which will contribute to the reduction of teachers' workload and the enhancement of their work level, and will ultimately promote the high-quality development of kindergarten science education and the all-round development of young children's bodies and minds. Firstly, with the assistance of robot teachers and virtual digital teachers, teachers will have the opportunity to free themselves from some repetitive and monotonous work as well as some non-teaching work, and the workload of teachers can be reduced. Secondly, with the aid of robot teachers and virtual digital teachers, teachers will be

able to keep abreast of the cutting-edge developments related to kindergarten science education, realize lifelong learning, and continuously improve their theoretical knowledge. Thirdly, robot teachers and virtual digital teachers can answer children's questions and accurately understand the status of each child during science activities and provide timely and appropriate assistance and response. This will greatly alleviate the difficulty of teachers to take into account the individual needs of all children in the process of kindergarten science education activities.

### 4.3. Creating a Science Education Evaluation System with Data for the Whole Process

Evaluation plays a pivotal role in the process of kindergarten activities, and effective evaluation can optimize the design of activities, promote the growth of young children, and promote the development of teachers. The current evaluation of kindergarten science education activities has a single dimension of evaluation objectives, one-sided evaluation methods, and evaluation is not carried out throughout the whole process of teaching and learning activities, thus, the current evaluation of kindergarten science education has not given full play to its due role.

In the era of the metaverse, with the support of digital twins, the Internet of Things, big data and other technologies, the formulation of evaluation objectives for kindergarten science education has become more scientific and targeted, the choice of evaluation methods more flexible and diversified, and the results of evaluations more practically effective. Specifically, the formulation of evaluation objectives. With the support of massive data, teachers will have a more intuitive and accurate understanding of children's cognitive development level, physical and mental development status, and existing life experience. In this way, teachers can, on the basis of a thorough understanding of young children, take into account the laws of their physical and mental development as well as the relevant provisions and requirements of the relevant policy documents, and formulate the most targeted assessment criteria for each child that can best promote his or her growth and development on the basis of his or her original foundation. In turn, the evaluation of science activities is no longer a suspended, procedural template, but a truly important tool for the present and future development of young children. Choice of evaluation methods. First, outcome evaluations are combined with value-added evaluations [13], thanks to the fact that the whole process of teaching and learning in the metaverse era is recorded and preserved in the form of data, teachers are not only able to accurately assess the degree of achievement of the objectives of this science activity, but also to evaluate the growth and development of each child through the activity, with the aid of the relevant data. As a result, teachers are able to more accurately predict children's zone of proximal development than in the past, which promotes the effective formulation of activity programmes and the precise provision of teaching scaffolds, and thus strongly promotes the high-quality development of kindergarten science teaching and learning activities, and better facilitates the holistic development of children's bodies and minds. Secondly, a combination of standardized and personalized assessment. On the one hand, as a collective teaching activity, the kindergarten science activity has its basic goal for all children, the whole process of data, intelligent evaluation system, so that the standardized evaluation for all children to achieve automation, the teacher can directly obtain the results

of the children's whether or not to achieve the unified goal of the activity data. This reduces teachers' workload while providing a basis for effective reflection on their teaching. On the other hand, the promotion of the personalized growth and development of each young child is a goal that education will relentlessly pursue in the future. The development of personalized assessment criteria is the first step in promoting the personalized development of young children, while their actual implementation is the more crucial part. The current kindergarten science education activities in the evaluation due to a variety of practical constraints, it is difficult to carry out personalized evaluation for each child. The metaverse era, with its comprehensive data, has led to a homogenization of evaluation content, which has facilitated the development of evaluation activities. At the same time, the comprehensive data makes those implicit, difficult to quantify, and difficult to effectively evaluate the content of the moment, such as children's mastery of scientific knowledge and the emergence of young children's scientific emotions, etc., can be in the brain-computer interface, human-computer interaction, big data and other technology support intuitively presented in front of the teacher, in the process of carrying out the activities of the teacher can be adjusted in a timely manner according to the relevant real-time data on the pace of teaching and evaluation. In the process of activities, teachers can adjust the pace of teaching according to the relevant real-time data in a timely manner, so that the evaluation can be carried out throughout the whole process of science education activities, and the scientificity, effectiveness and pertinence of science education activities can be improved. The collection of relevant data is a prerequisite for assessment, and rich and authentic data on young children's science learning contributes to the effectiveness of teachers' personalized assessment. As a result, the natural individual differences between children can be "seen" and valued with the support of data, and personalized assessment based on individual differences promotes children's growth and development to the maximum extent possible. Again, internal and external evaluations are combined. In terms of internal evaluation, the metaverse era allows teachers to return to the present moment of their teaching activities at any time through wearable devices, etc., and immerse themselves as bystanders in evaluating and reflecting on their own teaching activities, as well as evaluating the children's behaviors and performances during the activities. Immersive retrospectives help teachers to step out of their old complex networks and revisit the teaching activities they have carried out with a fresh perspective for individual growth. In terms of external evaluation, the metaverse's features of integrating the real and the imaginary and comprehensive data enable different subjects to sit together across time and space, and through analyzing the relevant data about the children, the teachers and the activities themselves recorded in the process of carrying out the scientific activities, we can achieve a multi-faceted and all-around evaluation of the scientific activities. In addition, the arrival of the metaverse era, while blurring the boundaries between the real and imaginary worlds, also allows the past, present and future to be fully interwoven, so that each subject of evaluation can return to the present moment when the science education activities are carried out with the help of wearable devices, and carry out an effective evaluation of the activities after participating in an immersive manner. As a result, the comprehensive data of the metaverse era promotes the effective development of internal and

external evaluation, and moreover promotes the organic combination of the two, and the quality of kindergarten science education can be improved, and the comprehensive development of young children's body and mind can be better guaranteed under the interaction of internal and external evaluation. Finally, teacher evaluation is combined with intelligent evaluation. Part of the evaluation content of kindergarten science education in the metaverse era has been intelligent and automated, and the organic combination of teacher evaluation and intelligent evaluation has promoted the improvement of kindergarten science education evaluation in terms of accuracy, comprehensiveness and pertinence.

## 5. Conclusion

The rapid development and wide application of modern technology is driving the development and change of all fields of society. For kindergarten science education, the arrival of the era of metaverse will provide an opportunity for the construction of science education scenarios based on real problematic situations and young children's life practice; for the transformation of science education methods throughout the day-life of young children, respecting young children's manipulation and experience; for the selection of science education content that is scientific, rational, highly planned and integrated with modern science and technology; for the rich integration of various types of science education resources; for the improvement of multi-subject, multi-dimensional and personalized science education evaluation; and for the construction of high-quality and professional science education teachers. The selection of science education content, the rich integration of various types of science education resources, the improvement of multi-subject, multi-dimensional and personalized science education evaluation, and the construction of high-quality and professional science education teachers will provide inexhaustible impetus. In the end, a real-time interactive science education environment that integrates reality and reality can be created, a science education teacher team that develops human-machine synergy can be built, and a science education evaluation system that is data-driven in the whole process can be established. As a result, it will promote the high-quality development of kindergarten science education in the era of the metaverse, better stimulate young children's interest in science, enrich their scientific experience, develop their scientific emotions, help them acquire scientific concepts, deepen their scientific knowledge and improve their scientific skills in the process of hands-on manipulation and problem solving, and promote the all-round development of young children's body and mind.

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