



GUIDELINES FOR THE PREPARATION OF EXHIBITS AND MODELS

All children are naturally motivated to learn and are capable of learning. The knowledge acquired by them is the outcome of their own activity. Children learn through interaction with people and environment around. They construct knowledge by connecting new ideas to their existing ideas.

In order to stimulate creativity, inventiveness and the attitude for innovation in science and mathematics, National Curriculum Framework (NCF-2005) emphasizes on activities, experiments, technological modules, etc. It also encourages implementation of various activities through a massive expansion of channels such as organisation of science, mathematics and environment exhibition at the national level for school students, with feeder exhibitions at school/block/tehsil/district/region/state levels.

The National Council of Educational Research and Training (NCERT), New Delhi organises Jawaharlal Nehru National Science, Mathematics and Environment Exhibition (JNNSMEE) for Children every year for popularising science, mathematics and environmental education amongst children, teachers and public in general. This exhibition is a culmination of various exhibitions organised in the previous year by the States, UTs and other organisations at district, zonal, regional and finally at the state level. Selected entries from all States and Union Territories, the Kendriya Vidyalaya Sangathan, the Navodaya Vidyalaya Samiti, Department of Atomic Energy Central Schools, Central Board of Secondary Education affiliated Public (independent) Schools, Central Tibetan Schools Administration and Demonstration Multipurpose Schools of Regional Institutes of Education participate in this

national level exhibition. Like in the past several years such exhibitions are to be organised from district to state level during 2021-22 too. These would form the first phase of preparation for the JNNSMEE to be organised in November 2022. The objectives of the exhibitions are:

- to provide a forum for children to pursue their natural curiosity, creativity, innovation and inventiveness;
- to make children feel that science and mathematics are all around us and we can gain knowledge as well as solve many problems by relating the learning process to the physical and social environment;
- to lay emphasis on the development of science and mathematics as a major instrument for achieving goals of self-reliance, socio-economic and socio-ecological development of the nation and the world;
- to analyse how science and mathematics have developed and are affected by many diverse individuals, cultures, societies and environment;
- to appreciate the role of science and mathematics in meeting the challenges of life such as climate change, opening new avenues in the areas of agriculture, fertiliser, food processing, biotechnology, green energy, disaster management, information and communication technology, astronomy, transport, games and sports etc.
- to create awareness about environmental issues and concerns and inspire children to devise

innovative ideas towards their prevention and mitigation.

Children are naturally inquisitive and innovate in response to a variety of problems confronting society and the world. If today's children get engaged in tackling problems, solving issues, and creating new ideas, we can make our children better prepared for tomorrow's challenges. There is a need to continuously innovate to meet the challenges before us. The rising aspirations of human community for the desire of more comfort and security have put tremendous pressure on the limited resources of the world leading to unequal access and unsustainable exploitation. This is resulting in unsustainable use of resources.

According to United Nations 'Global Resources Outlook 2019', the resource extraction has more than tripled since 1970 in the world, including a five-fold increase in the use of non-metallic minerals and a 45 percent increase in fossil fuel use. Similarly, a very important resource, fresh water is also experiencing acute stress worldwide. According to United Nations World Water Development Report 2019, over 2 billion people live in countries experiencing high water stress, and about 4 billion people experience severe water scarcity during at least one month of the year. Water has to be treated as a limited resource, with a far stronger focus on managing demand. Climate change and bio-energy demands are also expected to amplify the already complex relationship between world development and water demand. It is true that "Jal hi Jeevan Hai", therefore it is the responsibility of everyone to conserve and manage this very important resource. Keeping in view of the importance of water and sanitation the Government of India is increasing the level of investment in this area.

We all are aware that the problems faced by the world today are not confined to a particular city, state or country. Rather,

these are global problems and for solving these problems, all the countries of the world need to work in unison. To solve the problems of the world and to bring peace and prosperity for people and the planet, now and into the future, all the member states of United Nations adopted 'The 2030 Agenda for Sustainable Development' which includes 17 different Sustainable Development Goals (SDGs) along with 169 associated targets.

Sustainable development is defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This means we cannot continue using the resources at the current level as this will not leave enough for future generations.

Science and Mathematics act as powerful tools for investigating and understanding the nature and the world. They also play a crucial role in solving problems confronting the society and act as a major instrument for achieving goals of self-reliance and socio-economic development in a sustainable manner. To recognize and encourage these powerful tools so that the problems confronting the society can be overcome and a better sustainable future can be built through science and technology led solutions, the theme for the State Level Science, Mathematics and Environment Exhibition (SLSMEE) for Children during 2021-22 has been chosen as Technology and Toy.

The flagship programmes of the Government of India such as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Pradhan Mantri Jan Dhan Yojana (PMJDY), Pradhan Mantri Jan Arogya Yojana (Ayushman Bharat), Skill Development, the Swachh Bharat Abhiyaan (Clean India Campaign), Pradhan Mantri Ujjwala Yojana, Beti Bachao Beti Pado (Save the Girl Child, Educate the Girl Child) are some of the steps to achieve these sustainable goals.

The theme and sub-themes identified for SLSMEE 2021-22 are directly or indirectly focuses on achieving the sustainable development goals enunciated by the United Nations.

In this context, it is envisaged that children and teachers would try to analyze all aspects of the role of science and technology for sustainable development of the world. This will enable students and teachers to generate scientific and mathematical ideas and prepare models/exhibits for addressing various problems. Scientific ideas in this context may be regarding innovative ways of doing things, creating simple technologies/tools that meet new requirements; enabling the participation of the lower pyramid of the population in the development process through science and technology, creating an enabling innovation ecosystem in the country for enhancement of science, technology and mathematics.

However, there are instances when children and their teachers think of some ideas that are new and may be applicable in the future. Often such ideas may not be possible to be presented in the form of a model/exhibit. Organizers of exhibitions at all levels may provide opportunities to students and teachers to present such ideas in the form of presentations and discussions.

Children and teachers should identify where and how new processes, researches, and developments in science, technology and mathematics can bring a better future for the world.

Development of creative domain of a learner through teaching- learning process of science is an area which needs to be addressed to make experience of learning stimulating and exciting. For this, there is a need to engage learners in learning of science concepts in innovative ways which may help in all round development of a learner. Toys or games, which may be physical or virtual, are one of the learner

friendly tools for learning science. Toys have been used since time immemorial for playing which, in long run, resulted in developing their cognitive, psychomotor and affective domains. Over time the form of toys and the materials used to make toys has evolved, particularly with the growth/development of technology, however, the importance of toys in learning science continues. With this in view, the theme for the **State Level Science, Mathematics and Environment Exhibition (SLSMEE) for Children– 2021–22 has been chosen as ‘Technology and Toys’.**

Toys play an important role in developing different skills of an individual, such as problem solving, conflict resolution, how cause and effect work, etc., and these skills play an important role in their lives. Toys also nurture creativity and imagination and values, such as, cooperation, sharing, respect for others. Toys also play an important role in creating awareness about issues related to health, hygiene and cleanliness. The use of toys for science concepts becomes more relevant considering the declining interest of learners in learning science. On one hand, the traditional toys, which are struggling for their existence among learners in the present era, may be relooked at for use as a tool to transact science concept in an innovative manner. On the other hand, the emerging technologies may be explored to design newer toys, refining existing toys, reviving indigenous extinct toys, made of ecofriendly materials and looking for the possibilities for their use in learning science.

In this context, it is envisaged that students and teachers would try to analyze all aspects of the role of technology and toys in learning of science. This will enable students and teachers to generate ideas and prepare toys/models/exhibits for addressing various problems.

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The theme for **SLSMEE-2021-22** and **JNSMEE-2022, 'TECHNOLOGY AND TOYS'**, aims to cover sub-themes such as-

1. Eco Friendly Material;
2. Health and Cleanliness;
3. Software and Apps;
4. Transport;
5. Environmental and Climate Changes;
6. Mathematical Modelling

(Sub-themes listed above are suggestive. Students may choose any other sub-themes and develop exhibits involving Science and Technology & Toys)

A few exemplar ideas pertaining to the sub-themes listed in the context of the theme, for the development of exhibits are given below.

1. Eco-friendly Materials

The great revolution in Technological and Industrial area has boosted up the rate of environmental degradation. The beginning of environmental degradation has happened due to major use of technology in industries in the latter half of the eighteenth century. Now we look for some technologies and alternatives that will help us to overcome, reduce or reverse such impacts on the environment.

In today's world the environmental degradation and deterioration is occurring in an unmatched manner and thus making it difficult for all life forms to live a healthy life. Human population is not the only one facing different environmental issues but all the ecosystems and the life forms living in them are getting affected due to

injudicious use of natural resources. All other ecosystems like air, water and soil are being degraded by the pollution from different sectors like transport, domestic, industries and agriculture. Tons of waste is being dumped in landfills, which keeps getting accumulated in the environment and pollute it. Today we are facing major environmental problems such as climate change and global warming that requires an immediate attention.

Using eco-friendly or environment friendly materials in daily life activities and for manufacturing or industrial processes can solve the above mentioned issues and challenges to a great extent.

For an instance, environment friendly technologies and materials can be used so that both the manufacturing process involved and the product obtained by the process are more eco-friendly. The environmental challenges that we are facing nowadays call for an attention, therefore, development of such alternatives that protects our environment from degradation is the need of the hour. One of the solutions is using eco friendly materials on major level. Eco friendly materials act like a savior to the environment as it not only cause minimum environment degradation but also reduces the negative effects on all living organisms surviving in various ecosystems. Therefore, people should be encouraged to use eco-friendly materials in different technological developments and development of toys.

Awareness about the advantages of eco-friendly materials can be generated among people by making such models. Some examples of eco-friendly materials that can be used in making the models are:

- Used papers, used books, old carton

boxes, newspapers and other waste papers can be used to make models and toys.

- Plant based materials like cotton, jute fibres and other natural fibres can be taken in use for making various models as they serve as excellent eco-friendly materials
- For making base and frames of the model various other plants based materials like bamboo, cane and wood etc.
 1. Metals can be used as an alternative of plastic or polymers used in daily life such as polyvinyl chloride (PVC), or polystyrene products such as thermocol etc although metals are non biodegradable but they better than plastics
 2. Various models can be developed to showcase the advantages of eco-friendly materials/ alternatives in different technologies and toys.

2. Health and Cleanliness

The main objectives of this sub-theme are: to bring awareness among the children about the factors affecting our health and nutritional needs of the body; to explore new scientific, technological and bio-medical inventions in prevention and cure of diseases like Coronavirus; to explore various scientific and technological interventions for meeting nutritional requirement of human beings and innovative ideas for better management of the crisis created during COVID-19 pandemic.

The exhibits/models in this sub-theme may pertain to:

- factors affecting the health and resulting ailments in the body;
- to study as to how the cleanliness influence health;
- foods that improve our immunity to fight against diseases;
- improved methods and innovative ways of sanitation and appropriate technology for disposal of surgical masks, PPE kits, etc. and other biodegradable and non-biodegradable waste;
- the ways to dispose-off the garbage properly to maintain cleanliness;
- methods to improve rural sanitation;
- infectious and non-infectious diseases, relationship with causative factors and their sources with emphasis on Coronavirus;
- mechanisms/ways to control the spread of Coronavirus, Lung infections, Dengue, Malaria, Chikungunya, etc.;
- innovative preventive measures to control diseases at different levels/ roles of various agencies (role of individual to break the infection spread chain);
- demonstration and use of traditional methods of medication;
- demonstration of known facts and findings, and health benefits of physical exercise and Yoga;
- demonstrate importance of balanced diet and nutritional values of various food items;
- ways to raise awareness and sensitize people about the role of social distancing and measures/ innovative techniques to overcome issues in its implementation;
- role of biotechnology to improve nutritional value of crops;
- demonstration of models/projects to show the effect of junk food items, adulterated food items on our body and its preventive measures;
- demonstration of models/projects to create awareness among children about appropriate rules of safety in hazardous situations to avoid

- accidents and injuries;
- presenting medical assistance and facilities for rural/urban areas and gender aspects;
- ways to raise awareness and sensitise people to be careful in health matters, explore the possibilities and make use of the facilities available;
- innovative ideas for effective implementation of policies/ programmes/ schemes such as Swachh Bharat Abhiyan, National Leprosy Eradication Programm etc. that have significant impact on health;
- innovative ideas for effective implementation of policies / programmes/ schemes such as Atmanirbhar Bharat (self-reliant India) for making India a bigger part of the global economy;
- development of knowledge-base and understanding new scientific, technological aids in bio-medical areas;
- presentation of known facts and research findings in different medical systems like Traditional, Modern, Homeopathy, Ayurvedic, etc.;
- lifestyle and its relationship with good and bad health based on known facts and researches;
- common prophylactic measures available for different diseases and advantages of inoculation and vaccination;
- appropriate measures for family planning and welfare;
- ideas for developing low-cost, immunity boosting nutritious food;
- low cost medical diagnostic and therapeutic tools;
- toy/models for sustainable agriculture and health;
- toy/models to demonstrate the

impact of chemical residues from fertilizers, pesticides, hormones and food dyes etc., on health;

- new medical diagnostic and therapeutic tools/aids for physically handicapped persons for prevention from Coronavirus;
- innovative control measures at different levels / roles of different agencies;

3. Software and Apps

An interactive software is the one which allows direct communication between the user and a machine. When we are dealing with the toys, the machine refers to the toys. The main objective of this theme is to engage children and teachers in thinking of the new and innovative ways in which these type of software may be utilized in design and development of toys. Technology is providing us an edge in designing of newer type of games and toys!

On the other hand this theme may also include designing and developing Toy Programs. A toy program is a small computer program typically used for educational purposes. Toy programs are generally of little practical use, although the concepts implemented may be useful in a much more sophisticated program. Such toy programs usually ponder on specific problems, such as computing the n th term in a sequence, finding the roots of a quadratic equation and testing if a number is prime. Toy programs are also used for a developer trying out a new programming language, to test all of the language's syntax and coding methods.

The use of toys can help children learn and develop different skills such as problem solving, creativity, emotional and social development etc. It also helps in development of fine and gross

psychomotor skills. Technology has indeed changed the toys! Twenty years ago many of us were not in a position to think of the type of toys which are very commonly available today. Today, most of the beginner designers and developers still like to use their hands and the bricks at their platforms to develop new tasks. In some cases, they use prototype elements that are planned, proposed, or otherwise aren't ready yet. They occasionally use developing their thoughts with 3D printing technology (although sometimes they use good old-fashioned knives, scissors, or other tools to fashion "new" pieces out of existing ones that are similar). However master designers, use software and yes, again their own hands. Master Designers typically build models for promotional events like trade shows, tours, and so forth. Their models won't usually be made into sets that kids have to build (they'll often just be made once). Techniques like Injection Moulding are used for mass production of soft organic and McFarlane toys that we often see in restaurants, for example at McDonalds.

Most of the toy-developer programs today, are LEGO based. The word LEGO is an abbreviation of two Danish words "LEg GOdt", coined in early 1930s. It simply means play well in English. It has been the classic brick building toy of yesteryears. Nowadays, it's moved in all sorts of technological directions, including elaborate Mind storms; robotics based on programmable bricks originally conceived for educational purposes, and something approaching computer aided design (CAD).

Some specific questions that may be addressed while developing models under this sub-theme may include:

- What kind of modeling software can be used for designing prototype

toys: Solid works, Catia, On Shape, Autodesk Fusion, Sketch Up, Rhino, Zbrush, Zbrush core, T- Splines; Solid Works; Pro E; Rapid Form, Geo Magic, Rhino3D, Alias etc.

- What kind of software (tools) are used by the professional designers and engineers? Or how does a professional sculptor work for designing and building LEGO models? These could be L draw (or L draw standard), traditional CAD-style system design tools, Maya for three-dimension rendering, Leo CAD, Meca Bricks, LDD (LEGO Digital Designer), inventor, mud box, or some customized software.
- What are the free tools available for designing toys: Tinker CAD (for children that can also help in developing 3D modelling programs), Fusion 360, Blender, Sketch Up Free, Mesh mixer, Tsplines Add-on on your rhino software
- Is there any software that allow us to work on a mesh and convert it to a poly surface to be exported in other standard formats?
- What are the differences between different software?
- What kind of software is used to design and publish toys' instruction manuals?
- Which software is usually used by the package designers?
- How can I work as a toy designer?
- How can the pieces may be moved in LDD software?
- What software can be used for modeling soft stuffed toys and tiny toys?
- What kind of 3D modeling software is used for developing Video Games?
- How the prototypes do are tested?
- What are the software tools used for creating Toy Stories
- What software are generally used to

make jointed toys: Sensables or Jasun?

- What are the software for measurements, mechanical analysis etc.
- What is the best software to introduce children to 3D modelling and 3D printing
- What are the designing software used in 3D printing?
- What are the software used for industrial design?
 1. What 3D modeling software would be better for game development, and why?
 2. What CAD software is the most versatile?
 3. What kind of software is used for developing 3D models from a 2D image?

4. Transport

Learning through play is an important part of child's development. The use of toys can help children learn many different skills they need in their life. Toys can help develop problem solving skills, helps develop their motor skills and also nurtures their creativity and imagination.

Toys have existed in India since ancient times. Traditional Indian toys were simple and could connect to the real life knowledge. Available literature shows that toys have reflected the cultures, society and have played important role in the development of the physique and mind. It has been reported that assemble of toys were found in specific parts of the Indus cities, which could be interpreted as designated play areas. One tenth of all findings in the Indus valley are play-related, which included toys as well as game pieces like Wheel cart, Rattle, dice. A lot needs to be done to recover the lost heritage.

It is essential to create a platform

where young generation can showcase their innovative toys. Awareness among young generation needs to be initiated regarding the unhealthy manufacturing practices in the industry, waste control by rejecting plastic and electronic toys. Our society needs to be sensitized to the importance of organic toys. Toys can be used by children of all ages to see and recognize science embedded in their daily lives..

Students can design and develop two kinds of toys:

(a) Static and (b) Dynamic

Static toys, such as kites, dolls, animals, birds, etc., can be made of clay, bamboo, metals, paper or any locally available materials.

In dynamic category, moving or/and sound, light producing toys such as, *Damaru* or drum rattle, spinning top or *lattu*, *Gulel*, moving vehicles, dolls, robots etc., can be made. These toys would be useful in understanding the various concepts of science. Students can design advanced science toys, or prepare science projects, based on the simple toys they have played with as children Toys can also be used as teaching aid for transacting many concepts of science. These contribute in overall development of the child.

5. Environmental and Climate Changes

Changes in the environment and climate are perhaps amongst the greatest threats facing the world and humanity today. There are threats related to air, water and soil pollution on the one hand, while on the other, the impacts of such environment and climate change are observed in the form of heat and cold waves, episodes of storm and smog, erratic weather patterns such as drought, flood, unpredictable rainfall, loss of crop, water stress, increase in the intensity and frequency of cyclones, melting of

glaciers, sea level rise, global warming, increase incidence of zoonotic diseases such as SARS CoV-2, collapsing ecosystem, loss of biodiversity, forest fires, social conflicts, poverty, etc. These impacts not only threaten our development and economy but they are increasing becoming a threat to our very existence. While there are natural causes to the changes in the climate, the present changes in the environment and climate that we are experiencing are due to anthropogenic/ human activities—majorly attributed to developmental activities.

Notwithstanding the impacts of changes in environment and climate, we cannot entirely give up on our developmental activities since India is still a developing country. At the same time with increase in our population there will be corresponding increase in demand for all kinds of resources—food, water, energy, habitat, transportation, etc. Making all such resources accessible to all will impact the environment and climate in some way or the other. It is, therefore, imperative to invent and innovate strategies in order to ensure that all our developmental activities are sustainable with no, or minimal, impact to the environment and climate. Towards this end, a wide range of projects may be considered by students. Some areas on which students can develop their projects are listed below:

- Green or renewable energy from solar, wind, water, etc.
- Reducing air, water and soil pollution in rural and urban environment; agriculture, industries, manufacturing and transport sectors, etc.
- Reclamation of riverbanks and flood affected areas for the rehabilitation of landless people

- Solid waste management
- Water harvesting and ground water recharging
- Management coastal areas
- Reducing carbon and ecological footprint
- Green buildings
- Restoration and conservation of biodiversity—terrestrial and aquatic (freshwater and marine)
- Human susceptibility to infectious diseases through malnutrition due to climate stress and ways to controlling them/ studies of the impact of global warming on human health (spread of epidemic like dengue, malaria, zika virus, SARS CoV-2, etc.)
- Circular economy
- Social conflicts resulting from environment and climate change and their resolution (if possible, using case studies)
- Innovative designs/ methods of waste water recycling/ reclamation/ using recycled water in industries/ homes
- Innovative technologies/ designs of sanitation/ hygiene related issues
- Innovative designs for enhancing efficiencies of existing lighting system/ automobiles/ machines/ stoves/ chulhas
- Innovative devices for various purposes—measurement of pollutants, detecting forest fires, recording weather, diseases, etc.
- Mathematical modeling to show impact of environment and climate change on biodiversity
- Mathematical modeling to show impact of increase in population one environment and climate
- Mathematical modeling to show spread of forest fire depending on the types of trees, weather and nature of the ground surface, etc.

6. Mathematical Modeling

Mathematical modeling is the process of transformation of a physical situation into mathematical analogies with appropriate conditions. Physical situations need some physical insight into the problem. Then it is solved by using various mathematical tools like percentage, area, surface area, volume, time and work, profit and loss, differential equations, probability, statistics, linear, nonlinear programming, etc. It is a multi-step process involving identifying the problem. Constructing or selecting appropriate models, fighting out what data need to be collected, deciding number of variables and predictors to be chosen for greater accuracy, testing validity of models, calculating solution and implementing the models. It may be an iterative process where we start from a crude model and gradually refine it until it is suitable for solving the problem and enables us to gain insight and understanding of the original situation. It is an art, as there can be a variety of distinct approaches to the modelling, as well as science, for being tentative in nature.

In mathematical modeling, we neither perform any practical activity nor interact with the situation directly, e.g. we do not take any sample of blood from the body to know the physiology, and still our mathematical tools reveal the actual situations. The rapid development of high speed computers with the increasing desire for the answers of everyday life problems have led to enhanced demands of modeling almost every area. The objective of this sub-theme is to help children to analyse how mathematical modeling can be used to investigate objects, events, systems and processes. It can be visualised by Fig.1.

The exhibits/models in this sub-theme may pertain to:

- mathematical modeling to solve various problems of our everyday life/environment related problem;
- mathematical modeling and computer simulation of climate dynamics/prediction of weather phenomena based on a number of predictors;
- mathematical modeling in physical geography such as rotation and revolution of earth, precession and equinoxes etc.;
- mathematical modeling to predict orbital path of comets, meteors and other minor planets;
- mathematical modeling to show how disease might spread in human in the event of epidemics/bioterrorism;
- mathematical modeling to predict the devastating effects of wars/nuclear explosions;
- mathematical modeling to show spread of forest fire depending on the types of trees, weather and nature of the ground surface;
- mathematical modeling to demonstrate the action of medicines in human system;
- mathematical modeling of the working of heart, brain, lungs, kidneys, bones and endocrine system;
- computer diagnosis of human diseases;
- mathematical modeling of fluid flow in drain, spillways, rivers, etc;
- using mathematical modeling and computer simulation to improve cancer therapy/wound healing/tissues formation/corneal wound healing;
- mathematical modeling of intracellular biochemical reactions and metabolism;

- mathematical modeling to describe traffic flow/stock market options;
- Studies of storage and retrieval techniques for computer systems;
- Data manipulation and information management techniques;
- Statistics and random number problems;
- Developing video games;
- mathematical modeling for increasing production of crops;
- mathematical modeling on balance of carbon cycle;
- mathematical modeling on social insects such as honeybees, termites, etc. to know how they use local information to generate complex and functional patterns of communication;
- mathematical modeling of maximum speed in fibre optic links;
- mathematical modeling of urban city planning;
- mathematical modeling to prevent an unwanted future/to understand various natural and unnatural phenomena;
- mathematical modeling to show the effect of climate changes/global warming;
- mathematical modeling for predicting future population and knowing the impact of population;
- mathematical modeling for increasing production of crops etc.