e-Content for Teaching and Learning of Science: Policy Recommendations, Concept, Need and Scope

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Key initiative recommendations of NEP 2020

- Pilot studies for online education
- Digital infrastructure
- Online teaching platforms and tools
- Content creation, digital repository, and dissemination
- Addressing the digital divide
- Virtual labs
- Training and incentives for teachers
- Online assessment and examinations
- Blended modes of learning
- Laying down standards

Leveraging technology for teaching-learning (p 56)

National Education Policy (NEP) 2020

4.23. While students must have a large amount of flexibility in choosing their individual curricula, certain subjects, skills, and capacities should be learned by all students to become good, successful, innovative, adaptable, and productive human beings in today's rapidly changing world. In addition to proficiency in languages, these skills include: scientific temper and evidence-based thinking; creativity and innovativeness; sense of aesthetics and art; oral and written communication; health and nutrition; physical education, fitness, wellness, and sports; collaboration and teamwork; problem solving and logical reasoning; vocational exposure and skills; digital literacy, coding, and computational thinking;…….

National Education Policy (NEP) 2020

- **Virtual Labs: Existing e-learning platforms such as DIKSHA, SWAYAM and SWAYAMPRABHA will also be leveraged for creating virtual labs so that all students have equal access to quality practical and hands-on experiment-based learning experiences.(p. 59)**
- **Pedagogy must evolve to make education more experiential, holistic, integrated, inquiry-driven, discovery-oriented, learner-centred, discussion-based, flexible, and, of course, enjoyable. (p.3)**

Aims of science education NCFSE 2023 p213

- Developing understanding of scientific knowledge
- Developing the ability to use the skills of scientific inquiry
- Developing an understanding of how scientific knowledge evolves
- Developing an understanding of the connection between science and other curricular areas "
- Developing an understanding of the relationship between science, technology, and society
- Developing a scientific temper

What is Scientific temper?

- Scientific temper denotes an attitude of logical, rational and scientific thinking.
- A person having scientific temper enquire, search for evidences, reasons before accepting anything.
- She/he does not accept anything simply because it has come from an authority or someone she/he has faith.
- A person having scientific temper makes informed decisions and possess a rational outlook towards life.

What is Science?

- A way of thinking, questioning and gathering evidence.
- An skills of scientific inquiry
- A particular way of looking at nature.
- An approach to investigation and as a process of constructing knowledge.
- A rapidly expanding body of knowledge
- Science demands perseverance from its practitioners

Scientific inquiry skills

Scientific inquiry skills develops shapes their thought patterns and develops informed decision making skills.

Inquiry skills involve-

- **Posing and responding questions about surroundings events and phenomena**
- **Makes observations through senses and devices**
- **Planning and conducting investigations**
- **Engaging in discussion about observations and investigations**
- **Constructing explanations based on evidences and evaluating alternative explanations**
- **Communicating findings and ideas.**

Scientifically consistent questions are ……

- about objects phenomena and events of the natural world.
- related to scientific ideas rather than personal preferences
- not related to non- measurable phenomena
- answered collecting evidences that are measurable
- answered through observations,investigations,experiments.

Scientific investigations

Different kinds of questions suggest different kinds of scientific investigations.

- **Some investigations involve observing and describing objects, organisms, or events;**
- **Some involve collecting specimens;**
- **Some involve experiments;**
- **Some involve seeking more information;**
- **Some involve discovery of new objects;**
- **Some involve making models.**

An investigation may suggest additional questions that, when answered, may lead to a better explanation.

Why use e-content in Science

- Reduces teachers' workload
- Personalised
- Motivating
- Flexibility
- Multisensory
- Generates interest
- Simplify abstract ideas
- Develops inquiry skills of science
- Saves time
- Develops self-learning skills
- Innovative
- Develops creativity
- Creative learning-teaching
- Develops self-learning skills
- Inclusive
- Dynamic learning-teaching
- Learner centred
- Easy communication
- Accessible
- Collaborative
- Opportunity to develop own learning-teaching materials

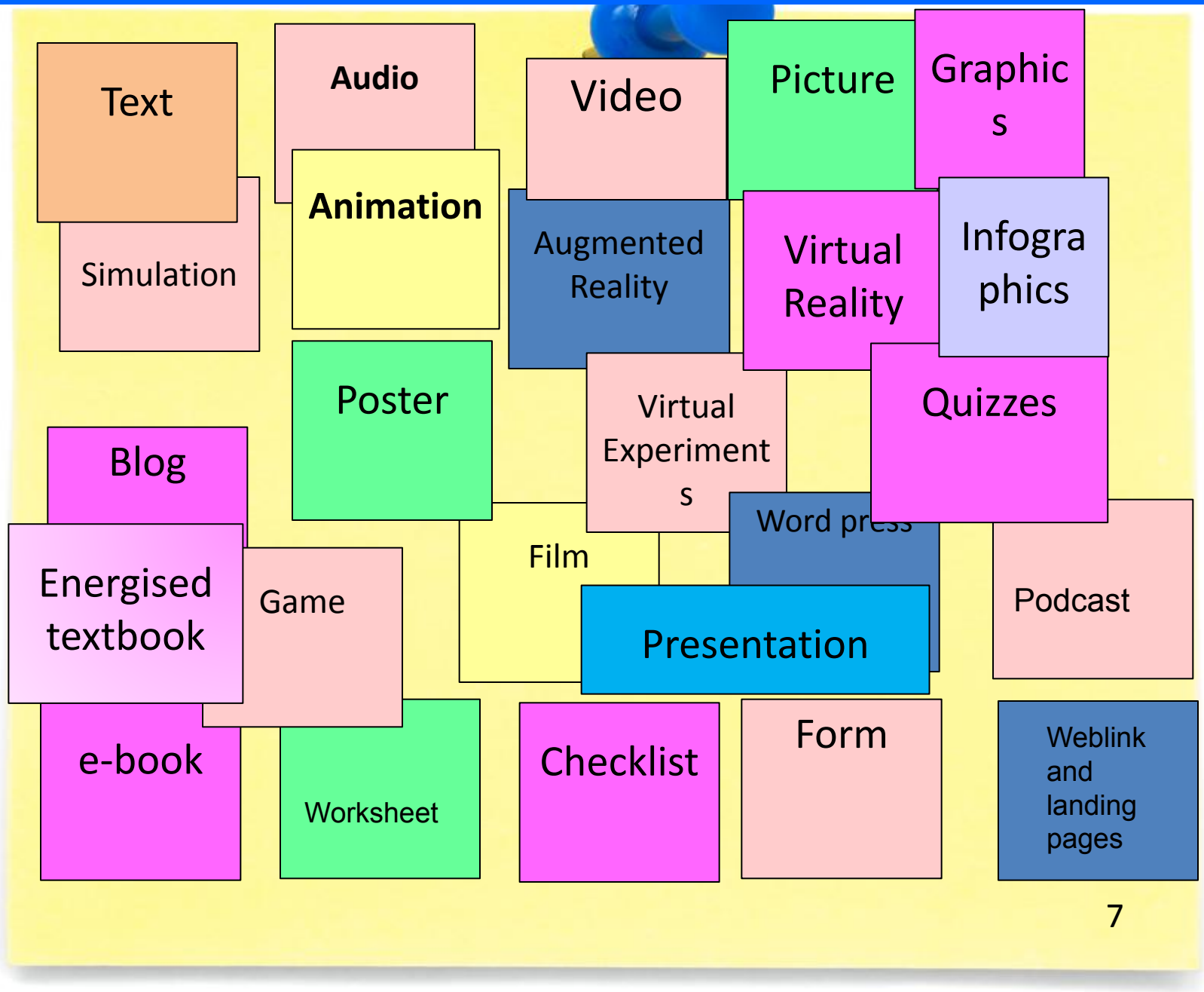
Why use e-Content in Science

- More time to reflect on data,making predictions, making interpretation
- Can focus on underlying scientific concepts
- Can analyse abstract,complex and microscopic phenomena
- Develop investigative and interpretative skills
- Develops problem solving,critical thinking and conceptual understanding
- Develops skills of modelling and hypothesising

e-Content can be ....

- Informative
- Experiential
- Communicative
- Constructive

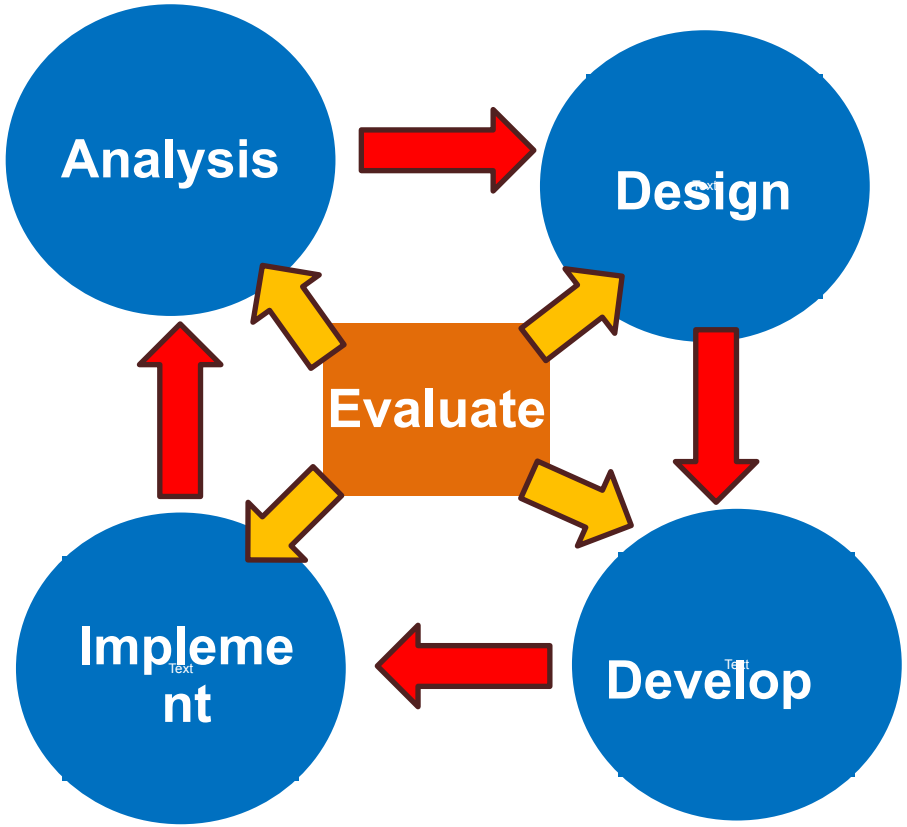
e-contents: various forms



ADDIE model of instructional design

- Analysis
- Design
- Development
- Implement
- Evaluate

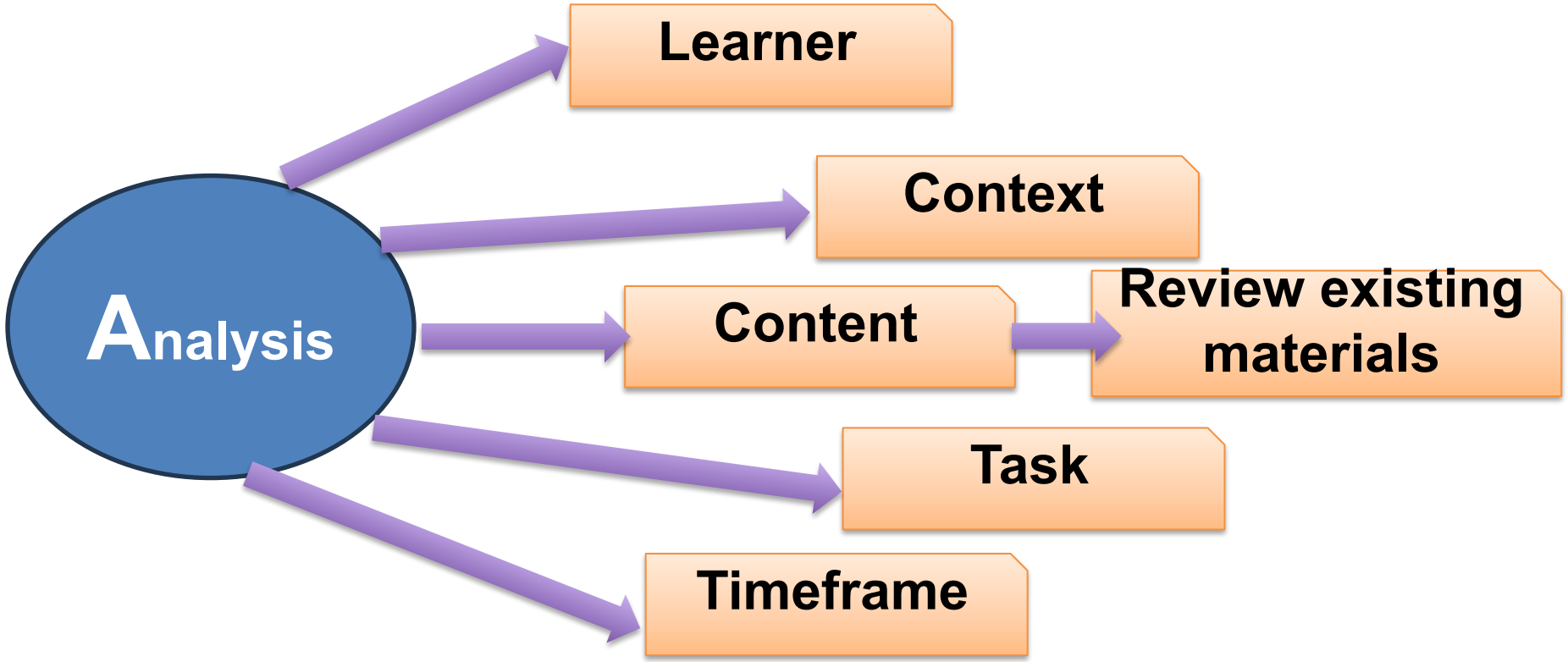
Why choose a model?



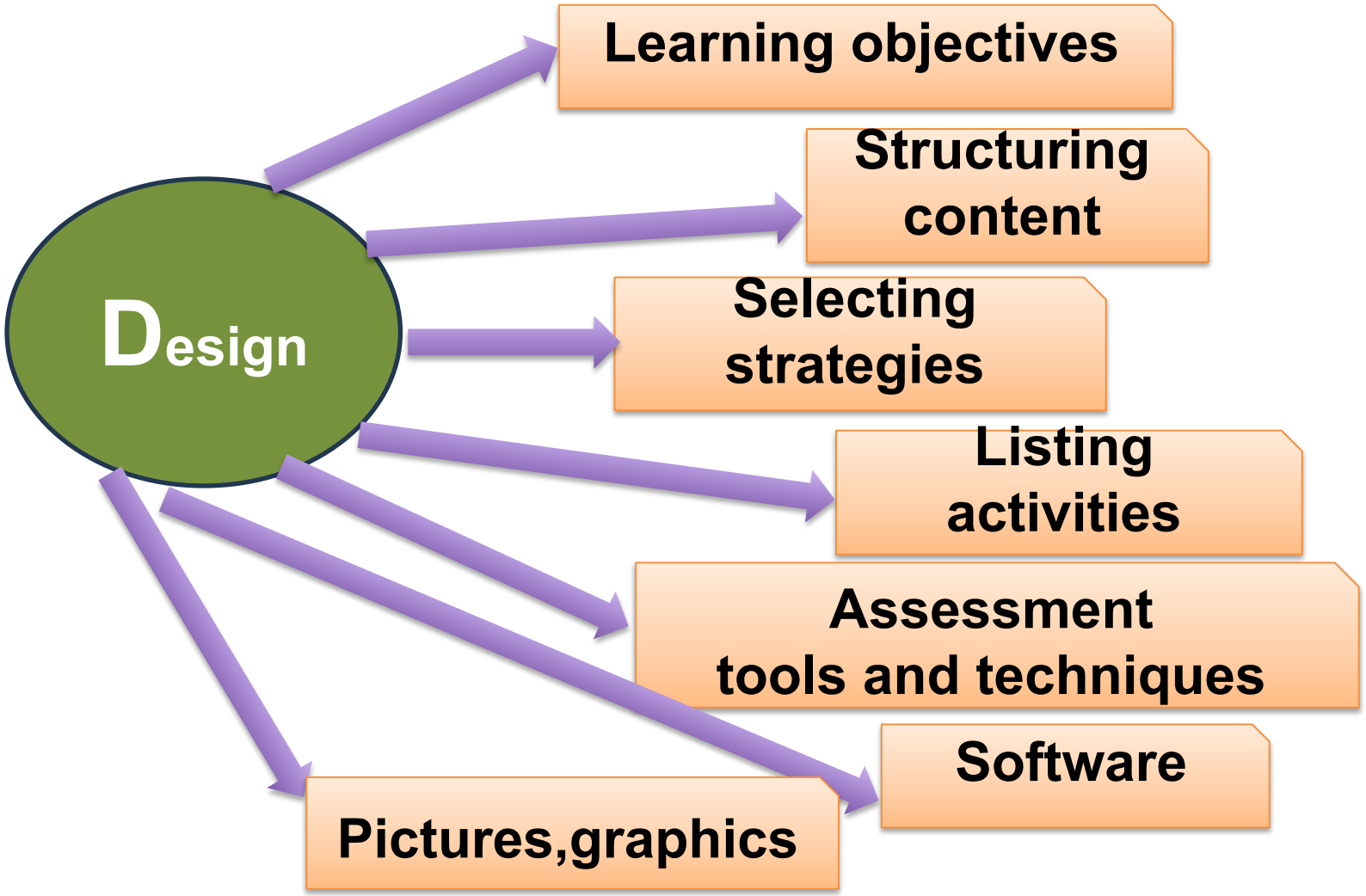
- Working systematically
- Saving time
- Developing step-by-step guidelines
- Making teaching-learning effective

ADDIE model of instructional design

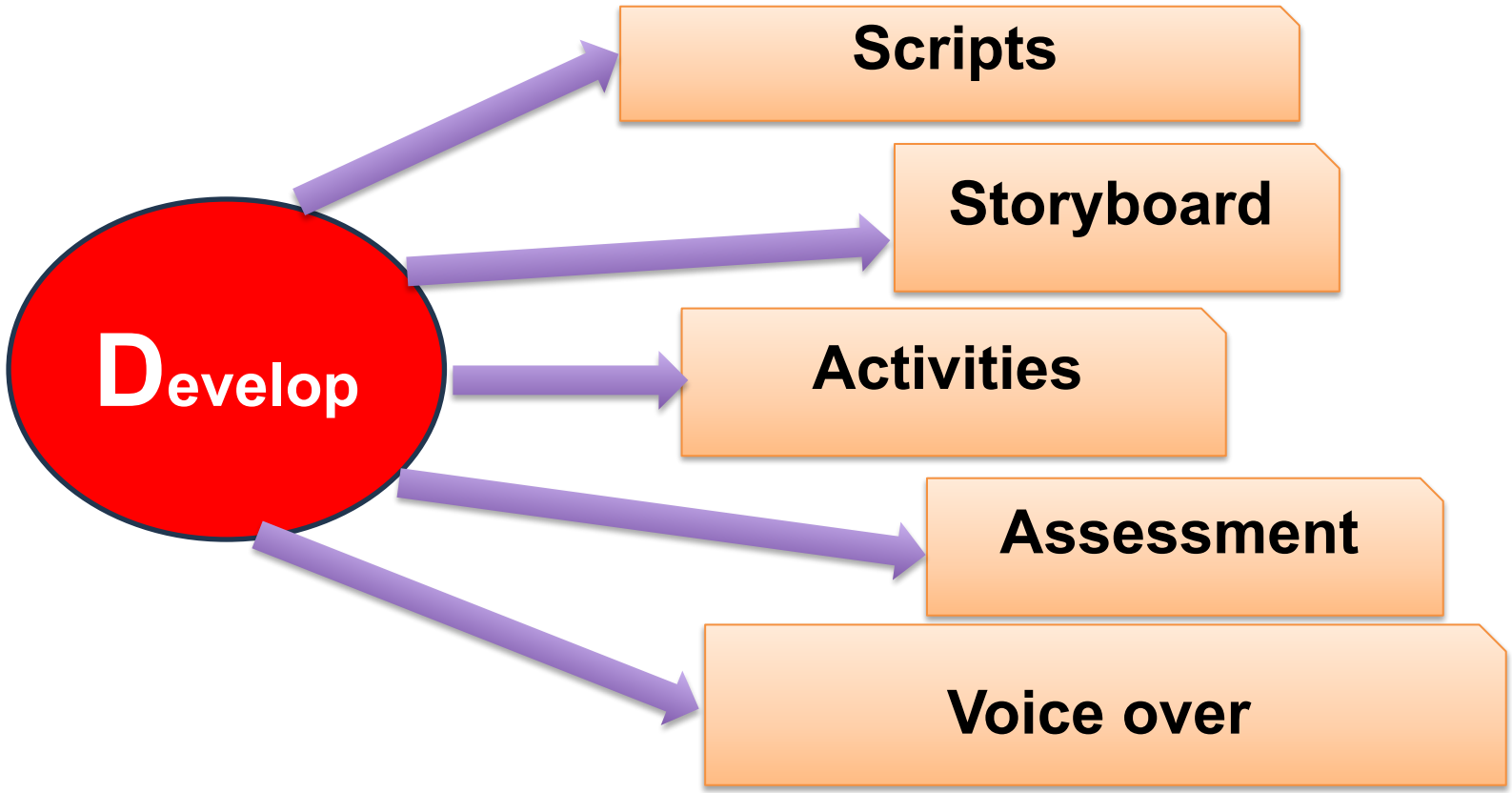
ADDIE model: Analysis



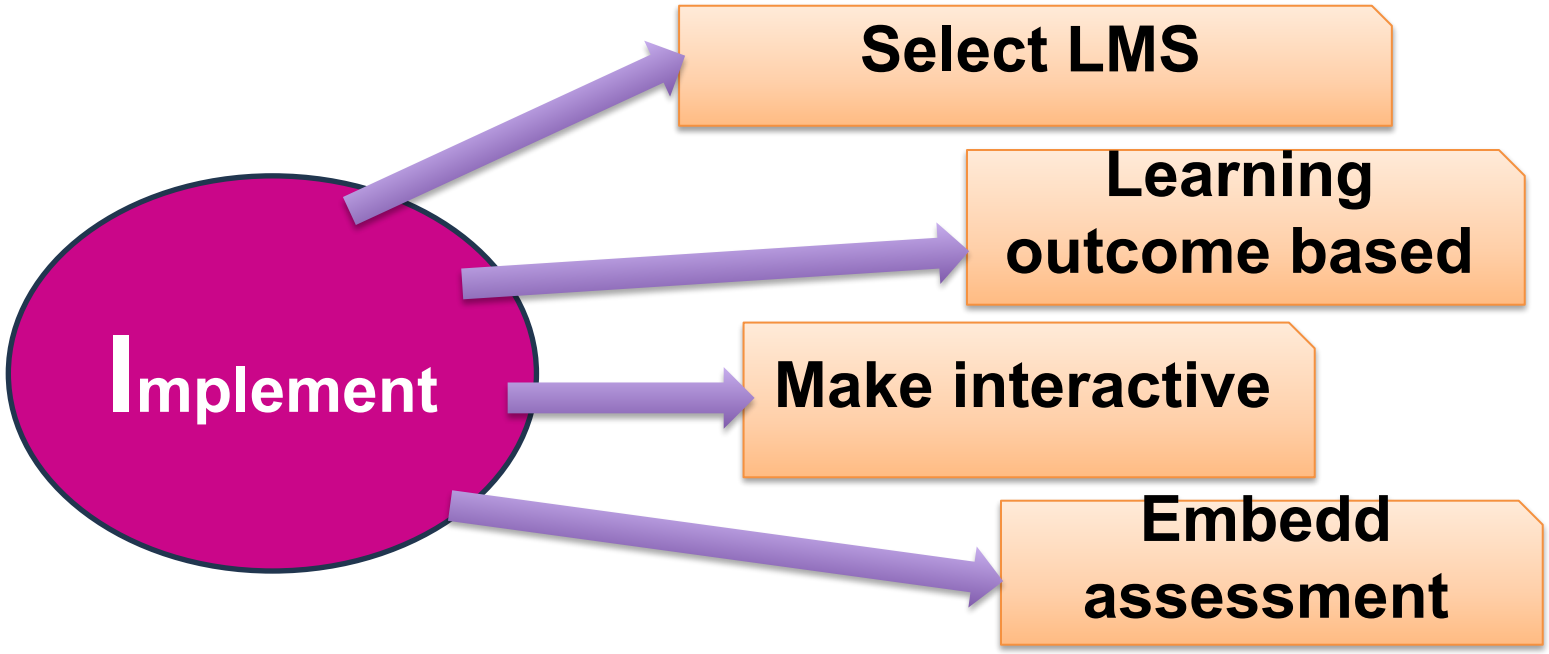
ADDIE model: Design



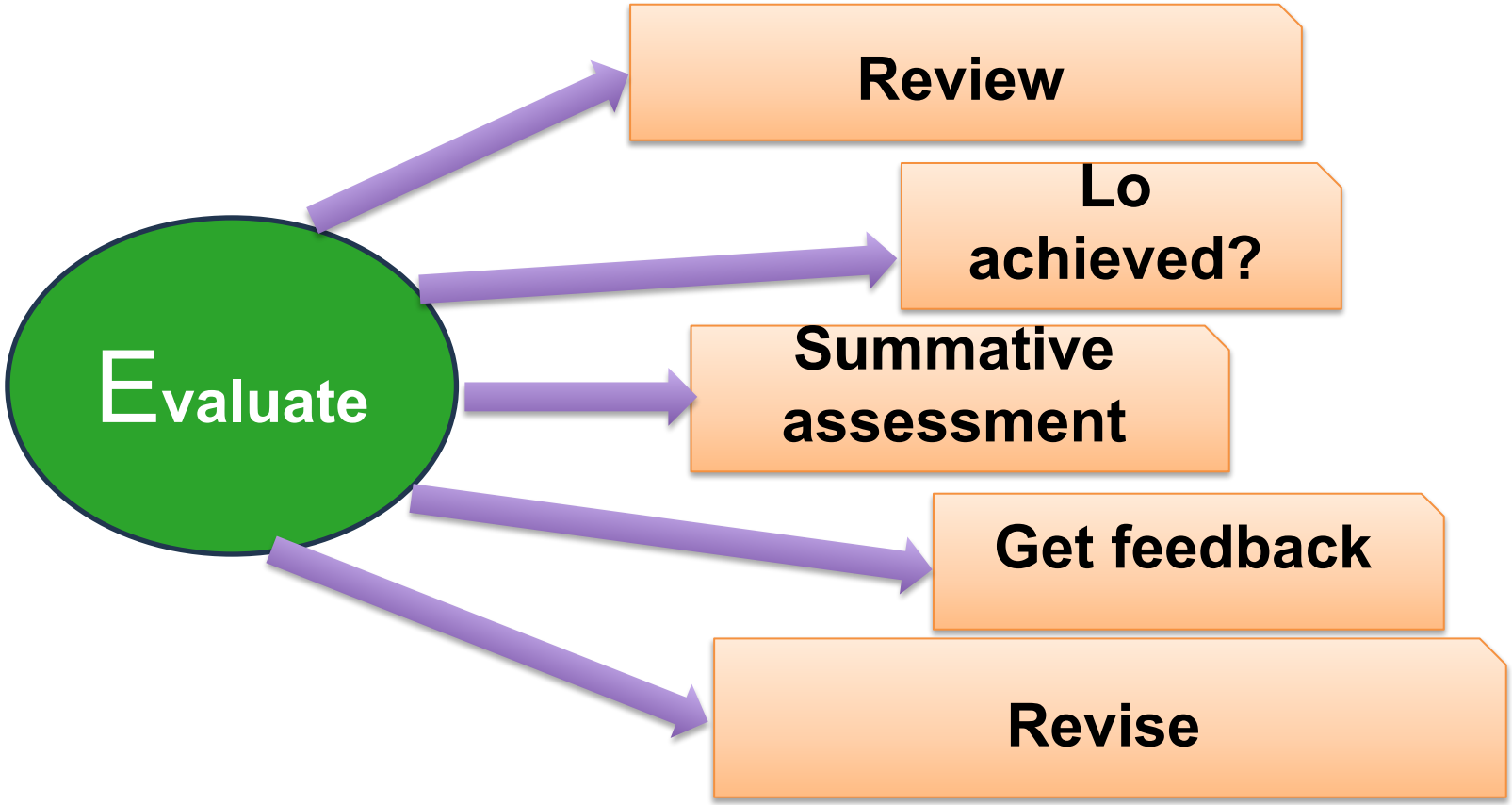
ADDIE model: Develop



ADDIE model: Implement



ADDIE model: Evaluate



Multiple strategies can be integrated with e- content

- Laboratory work
- Classroom learning-teaching: blended /hybrid learning
- Inquiry
- Assignment
- Exercise
- Demonstration + discussion
- Prediction and testing/retesting
- Group work
- Individual work
- Investigatory project

Multiple strategies can be integrated with e content

- ☐ Discussion
- ☐ Open ended questions
- ☐ Argumentation
- ☐ Project work
- ☐ Field visit, community involvement
- ☐ Survey
- ☐ Interview
- ☐ Activity/Experiment
- ☐ Exploration
- ☐ Role play
- ☐ Drawing/Art integrated approach
- ☐ Sports/game integrated pedagogy
- ☐ Digital story
- ☐ Historical approach
- ☐ Quiz

Facilitate investigations to nurture scientific temper

Different kinds of questions suggest different kinds of investigations.

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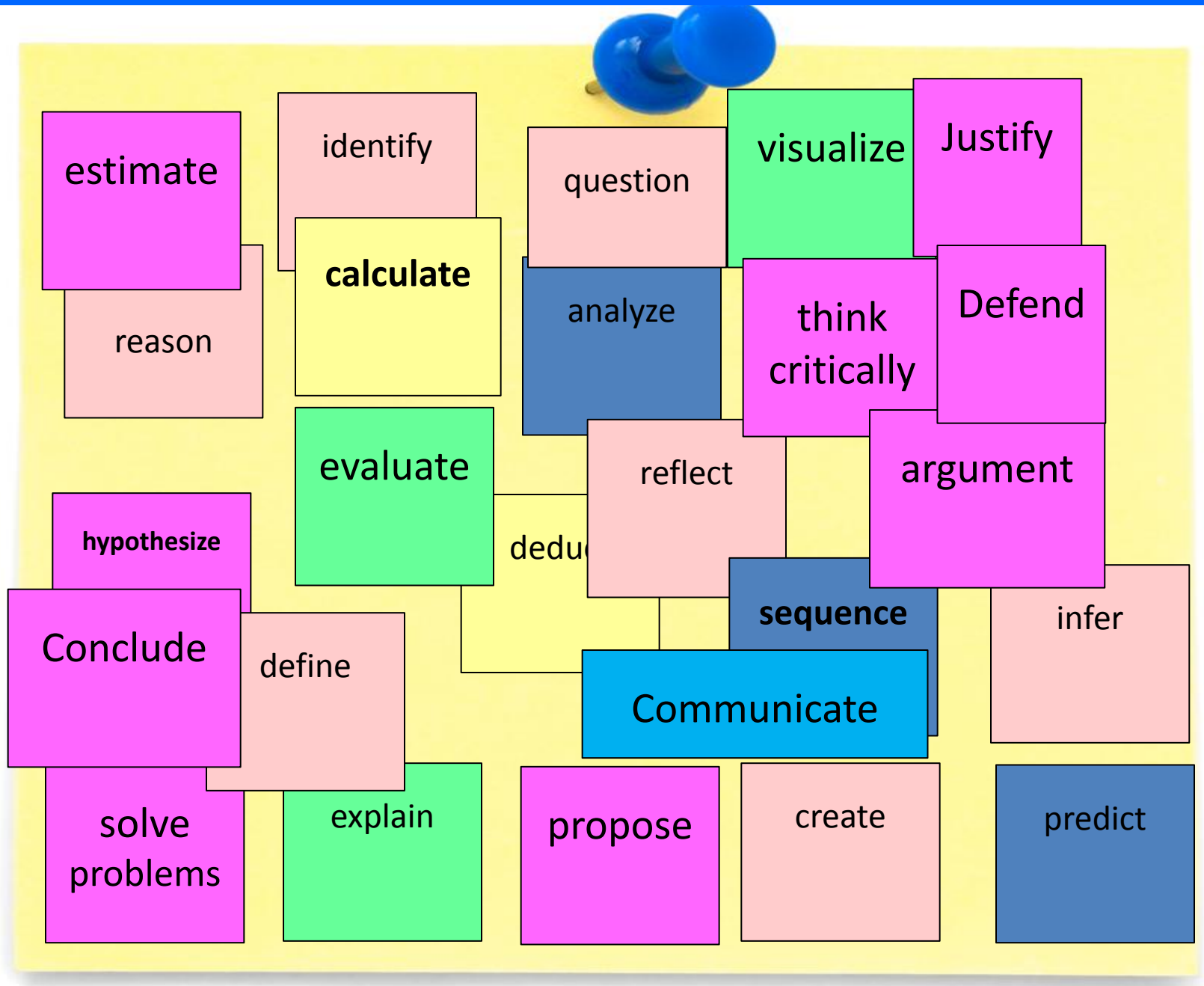
Integrating assessment with e-content

The test items should include six cognitive aspects-

- **Remembering**
- **Understanding**
- **Applying**
- **Analyzing**
- **Evaluating**
- **Creating**

e-content should provide students opportunities to



e content should encourage to ask questions

- How can you explain the observation?
- Why do you think that way?
- What do you think about the reason for your answer?
- Can you think of another argument for/against your view?
- How do you know what you know?
- What is the evidence of your knowledge?

e content should encourage to ask questions

- Allow students to seek out answers on their own and be careful about plagiarism.
- Guide and direct him to reliable source of reference and information.
- Use of collaborative language.
- Encourage students to find scientific evidence for results and conclusions that they arrive at.
- Encourage the learners to put their questions as well as to response to other’s questions or viewpoints with suitable reasoning and argument with social etiquettes.

Developing e contents for teaching-learning of science

Teacher facilitates students to -

- **activate prior skills, knowledge, understanding.**
- **generate and develop ideas**
- **gather information and evidences**
- **give explanations with evidence**
- **think about cause and effect**
- **think logically and seeking patterns**
- **evaluate evidences, information and ideas**
- **make rational decision/conclusion.**

Provide opportunity to students to …..

- realise that learning to learn and the willingness to unlearn and relearn are important as means of responding to new situations in a flexible and creative manner.
- Ask open-ended questions such as involving verbs ‘your point of view.., what do you think about it (say a phenomena)..’ ‘Assume that’.., ‘support/justify/interpret’, etc.
- Consider alternative ways of solving a problem; answering a question;doing awork and justifying it.
- review the work done for its further improvement
- Identify the aspects that are for and against the way adopted.
- Focus on relevant scientific facts
- Reflect on the previous work to identify the mistakes and avoid those in the next.
- Remove the fear of being wrong.

Subject Specific Softwares

JMOL
(http://jmol.sourceforge.net/)
(Chemistry)

AVAGADRO
(https://avogadro.cc/)
(Chemistry)

MARBLE
(https://marble.kde.org/)
(Science)

https://phet.colorado.edu/

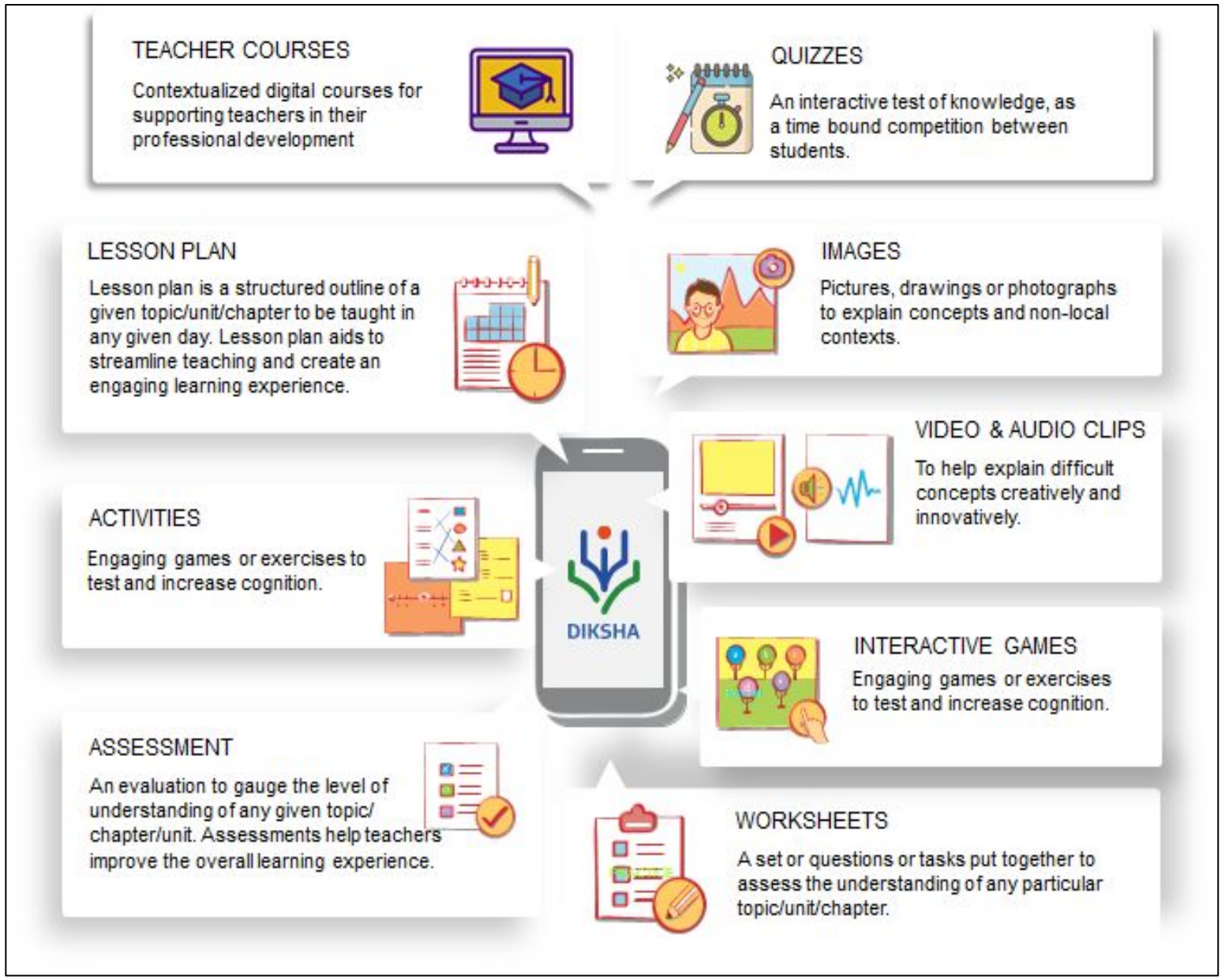
STRELLARIUM
(https://stellarium.org/)
(Science and Social Science)

GEOGEBRA
(https://www.geogebra.org/?lang=en) (Maths)

https://edu.kde.org/kgeography/

- KALZIUM (Chemistry)
- STEP(KDE) (Physics)
- ACD/ChemSketch (Chemistry)
- SAGEMATHS (Maths)
- GOOGLE EARTH (Science)
- QGIS

DIKSHA


TEACHER COURSES
Contextualized digital courses for supporting teachers in their professional development
QUIZZES
An interactive test of knowledge, as a time bound competition between students.
LESSON PLAN
Lesson plan is a structured outline of a given topic/unit/chapter to be taught in any given day. Lesson plan aids to streamline teaching and create an engaging learning experience.
IMAGES
Pictures, drawings or photographs to explain concepts and non-local contexts.
VIDEO & AUDIO CLIPS
To help explain difficult concepts creatively and innovatively.
ACTIVITIES
Engaging games or exercises to test and increase cognition.
DIKSHA
INTERACTIVE GAMES
Engaging games or exercises to test and increase cognition.
ASSESSMENT
An evaluation to gauge the level of understanding of any given topic/ chapter/unit. Assessments help teachers improve the overall learning experience.
WORKSHEETS
A set or questions or tasks put together to assess the understanding of any particular topic/unit/chapter.

PM e-VIDYA focuses on unification of efforts, enabling multi-mode access to education

PM e-VIDYA

https://ciet.nic.in/pages.php?id=pmevidya&ln=en

PM e-Vidya focuses on developing multi channel learning continuum

Television	Radio	DIKSHA	Special e-Content	Online Courses
One Class, One TV Channel	Radio Broadcast / Podcast	One Nation, One Platform	E-content for specially DIVYANG (CWSN)	Top 100 Universities to start online courses

An example of Augumented Reality

https://drive.google.com/file/d/19NPfkjBrtz4DzHcH144JJvKbybcn9E4Z/view?usp=sharing

Gamified learning

Students test their ideas, discuss their understanding with their peers and teachers, through interacting with scientific phenomena.

https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_all.htm

I

Make it short-bite size
Keep learner interestedandengaged- include multiple startegies
Make itintractive
Use FOSS

Approaches of e-content teaching –learning

- Blended learning
- Flipped learning
- Adaptive learning
- Hybrid learning
- Virtual Classroom

Virtual laboratory is used to …

- Enhance conceptual understanding
- Integrate it with relevant concepts
- Illustrate various concepts
- Familiarise with apparatus and equipment
- Develop science process skills
- Develop independent thinking and decision making

Objectives of laboratory work

Textbook of Pedagogy of Science (NCERT, 2013) suggests that use of laboratory must be focused towards achieving the objectives of developing

(a) cognitive abilities, i.e. principles and laws discussed in the classroom may precede or follow the laboratory work or it may be carried

out during discussion;

(b) process skills of science;

(c) scientific attitude and

(d) understanding nature of science.

Objectives of laboratory work

objectives.

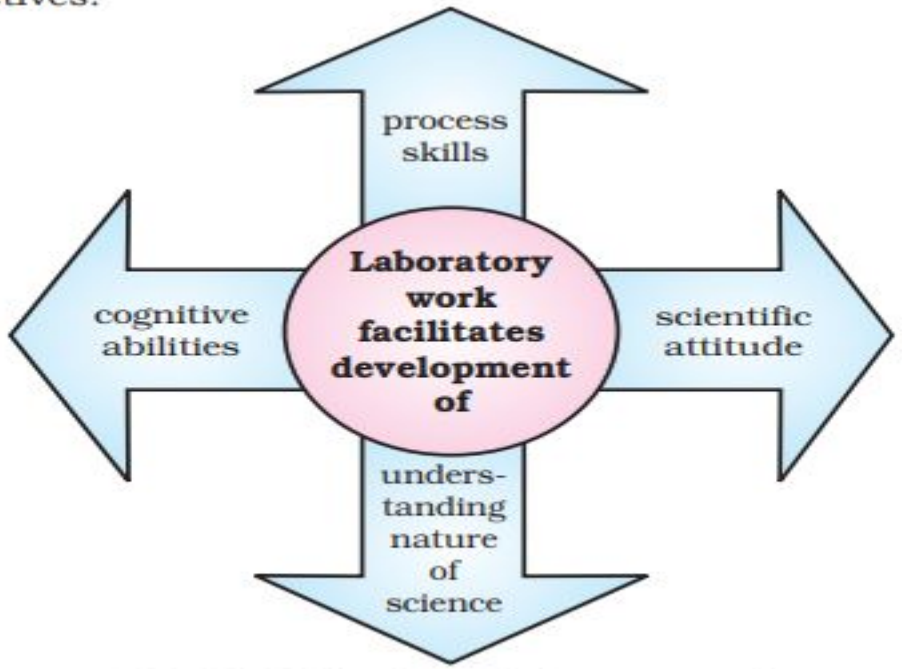


Fig. 9.4 *Objectives of laboratory work*

Emphasis should be given to the first five letters of LABORATORY rather than the last seven letters.

Role of the laboratory

- enhanced learning outcomes
- development of scientific attitude
- critical thinking,
- conceptual understanding
- development of science process and inquiry skills,
- manipulative skills,
- interests
- retention of students in science education
- ability to become independent learners

Attributes of scientific temper

- Respect for evidence
- Curiosity
- Open mindedness
- Suspended judgement
- Critical thinking
- Logical thinking
- Ability to sieve relevant information,facts,concepts from the pool of irrelevant ones
- Scepticism
- Objectivity, unbiasedness
- Truthfulness in reporting observations
- Aversion to superstitions
- Perseverance

Developing e- content in science

- Focus on the thinking and reasoning skills of students that support the formation and modification of concepts and theories about the natural and social world.

➢Facilitate to develop skills involved in inquiry and experimentation.

➢ Facilitate students to make logical relationships between evidence and explanations.

➢ Support them to develop descriptions, explanations, predictions, and models on the basis of evidences.

➢ Help them to evaluate evidences , and inference drawn that leads to conceptual change for conceptual understanding.