

Emerging Technologies for Effective Teaching & Learning

Continuing Education Program for Next Education India Pvt Ltd

Conducted by Educational Technology, IIT Bombay

September 19 - 21, 2018



Next Education™
Transforming Education



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Effective integration of technology

Sahana Murthy
Gargi Banerjee

Strong pedagogy + meaningful technology

trumps

Sophisticated technology + mediocre pedagogy

Strong pedagogy + meaningful technology

trumps

Sophisticated technology + mediocre pedagogy

Technology must be chosen so that it can support meaningful pedagogy.
Pedagogy must be designed so that it meaningfully exploits technology.

Strong pedagogy + meaningful technology

trumps

Sophisticated technology + mediocre pedagogy

Technology must be chosen so that it can support meaningful pedagogy.
Pedagogy must be designed so that it meaningfully exploits technology.



Frequently asked questions during demo

How to use the technology well?

How to incorporate technology in the teaching-learning process?

What should a teacher do with the technology in the classroom for effective learning?

...

How to effectively integrate technology?



Getting to know each other better

Each one say one

- Your name
- Your school
- Which technology do you want to “effectively integrate”
– list one.

Which technology do you want to effectively integrate



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*



Frequently asked questions during demo

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...

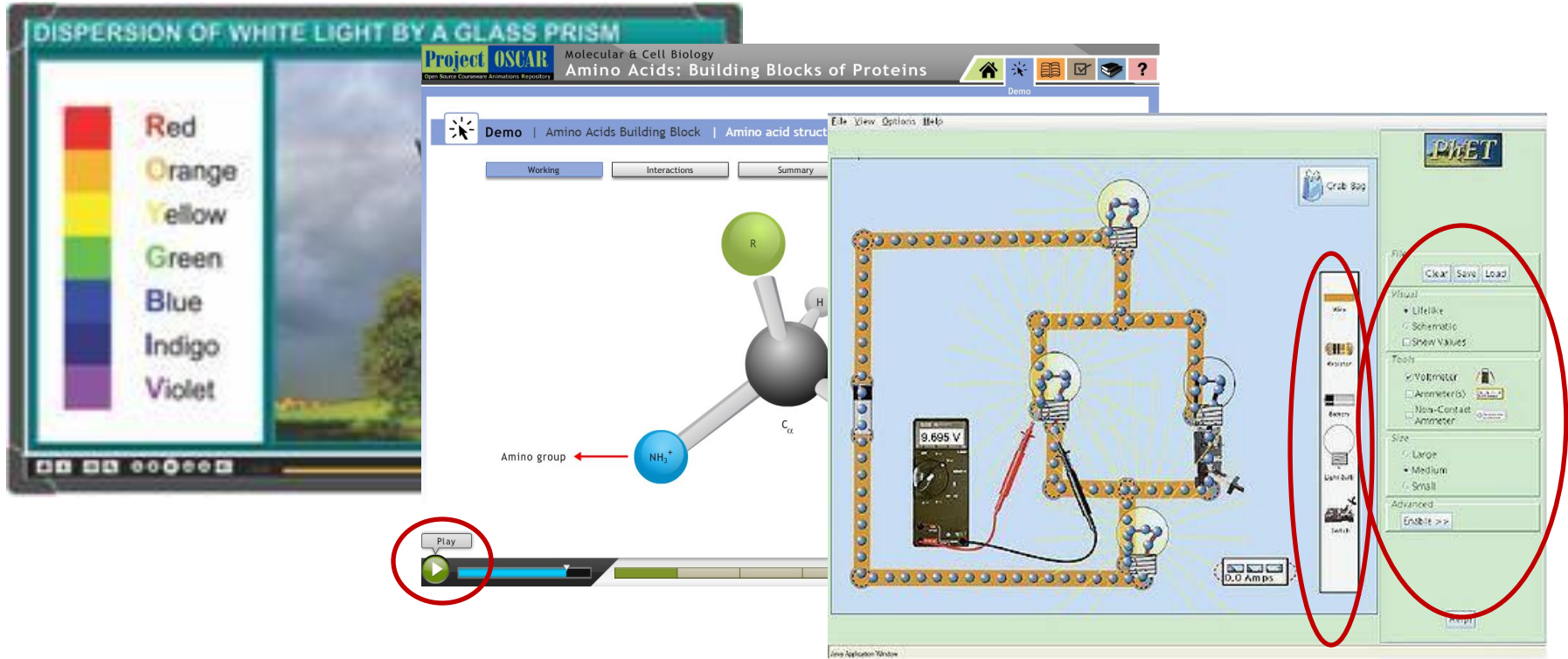
How to effectively integrate technology?



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Visualizations (familiar, commonly available)

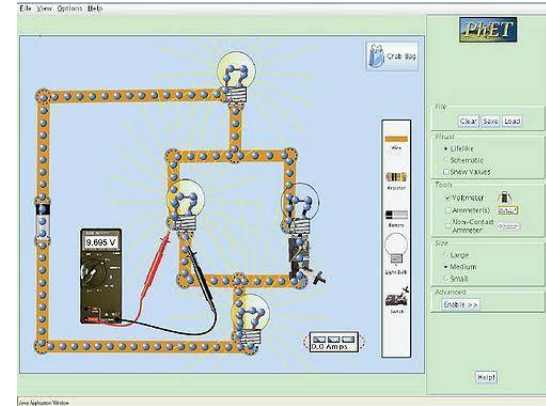
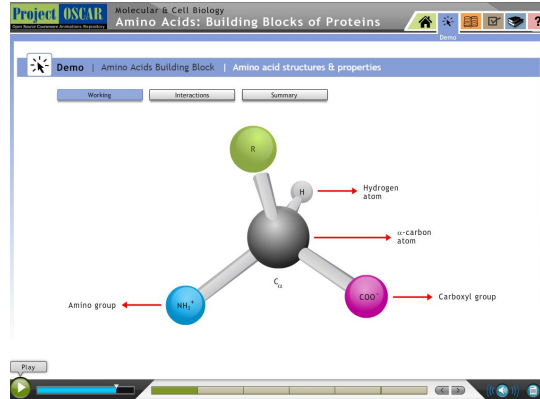
Visualizations in teaching-learning



The image displays three educational software interfaces:

- Left Interface:** Titled "DISPERSION OF WHITE LIGHT BY A GLASS PRISM", it shows a vertical spectrum of colors: Red, Orange, Yellow, Green, Blue, Indigo, and Violet.
- Middle Interface:** Titled "Project OSCAR Molecular & Cell Biology Amino Acids: Building Blocks of Proteins". It features a ball-and-stick model of an amino acid with a central carbon atom (C_{α}) bonded to a hydrogen atom (H), an R group, and an amino group (NH_3^+). A red arrow points to the amino group with the label "Amino group". A "Play" button and a progress bar are visible at the bottom left.
- Right Interface:** A circuit simulation software titled "PIET". It shows a circuit with a battery, a voltmeter displaying "9.695 V", and a switch. A red circle highlights the "Tools" and "Advanced" sections on the right side of the interface.

Visualizations in teaching-learning



Visualizations – videos, animations, interactive simulations
Many repositories
Shown to provide learning benefits

Why do teachers use visualizations in class?



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Why do teachers use visualizations in class?

- Make invisible visible– atoms, cells ...
- Ability to visualize – 3D, internals ...
- Improved conceptual understanding
- Higher motivation, engagement
- Easier / less boring than blackboard

Learning goals

Imp goal but not always same as learning

Sometimes we have this goal

How do most instructors use visualizations in class?



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How do most instructors use visualizations in class?



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- Teacher will play/ show/ demonstrate visualization, along with narrative explanation
- Students will watch and ask for clarification if needed

Vote



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Does demo + explanation of visualizations improve learning?

- 1) Yes
- 2) No

Visualizations and learning: Evidence from research



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[Demo + explanation] by itself is not effective

Potential benefits of visualization is lost if students merely watch & hear

Visualizations and learning: Evidence from research



[Demo + explanation] by itself is not effective

Potential benefits of visualization is lost if students merely watch & hear



Active-learning strategy with visualization led to improved outcomes

(Laasko et al 2009; Windschitl & Andre 1998, Banerjee, Murthy & Iyer 2015)

Example – active learning with visualization



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Example – active learning with visualization

A helium balloon is attached to a string tied to the bottom of a cart on wheels. The sides of the cart are encased in clear plastic. A person will abruptly push the cart to the left.



Example – active learning with visualization

A helium balloon is attached to a string tied to the bottom of a cart on wheels. The sides of the cart are encased in clear plastic. A person will abruptly push the cart to the left.

VOTE - Will the balloon move?

- 1) No it will stay in place
- 2) Yes, backward
- 3) Yes, forward



Example – active learning with visualization

- Watch the video.
- *Did the balloon move?*
 - 1) No it stayed in place
 - 2) Yes it moved backward
 - 3) Yes it moved forward



Example – active learning with visualization

- Watch the video.
- *Did the balloon move?*
 - 1) No it stayed in place
 - 2) Yes it moved backward
 - 3) Yes it moved forward

Did you change your answer?



Summary – active learning with visualization

Observe phase

TEACHER:

- Play viz upto the point the stimulus is shown.
- PAUSE before result. Don't show rest of viz yet.

STUDENTS:

Observe first part of viz

Predict phase

TEACHER:

- Ask students to make prediction: “What will happen if ...”

STUDENTS:

- Make prediction – write / vote
- Discuss w each other

Check & explain phase

TEACHER:

- Shows rest of viz, which contains result

STUDENTS:

- Check their prediction by viewing the result in viz
- Explain reason and discrepancies if any

Program visualization

Predict output (or next step) of program

Observe Step 4 & Predict step 5

Pointer Arithmetic
Text

Back
Forward

Program Code:

```
#include <stdlib.h>
int main() {
    char x[3] = {'a', 'b', 'c'};
    char* y = x;
    printf("Element 0 = %c\n", *y);
    printf("Element 1 = %c\n", *(y+1));
    printf("Element 2 = %c\n", *(y+2));
    printf("Element 1 = %c\n", *(-y));
    printf("Element 1 = %c\n", *(y++));
    printf("Element 2 = %c\n", *y);
    printf("Element ? = %c\n", *(y+1));
    return 0;
}
```

Program Output:

```
Element 1 = b
```

Explanation:

Here, the expression "y+1" returns the address 61, which is then dereferenced by * to return the value stored at 61.

Addr...	+ 0	+ 1	+ 2	+ 3	Variable
60	a	b	c		x
56				60	y
52					
48					
44					
40					
36					
32					
28					
24					
20					
16					
12					
8	program code	program code	program code	program code	
4	program code	program code	program code	program code	
0	reserved by the operating system				

Study: Viewing vs Prediction

Controlled study, 2 groups:
Viewing group (95 students)
Prediction group (136 students)

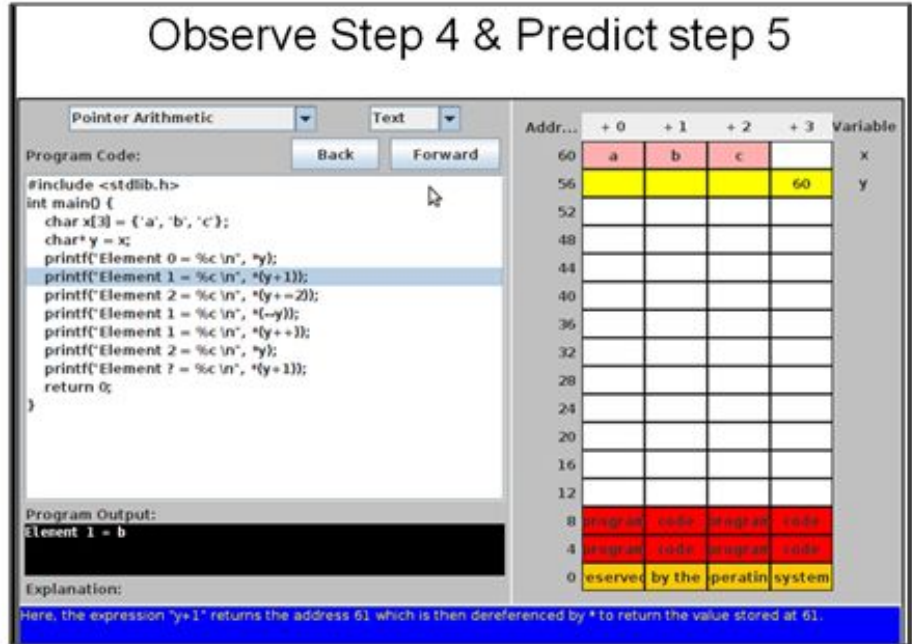
Results:

For Prediction group

- Higher engagement in class
- Higher rate of problem-solving

(Banerjee, Murthy & Iyer 2015)

Observe Step 4 & Predict step 5



The screenshot shows a C program editor with the following code:

```
#include <stdlib.h>
int main() {
    char x[3] = {'a', 'b', 'c'};
    char* y = x;
    printf("Element 0 = %c\n", *y);
    printf("Element 1 = %c\n", *(y+1));
    printf("Element 2 = %c\n", *(y+2));
    printf("Element 1 = %c\n", *(-y));
    printf("Element 1 = %c\n", *(y++));
    printf("Element 2 = %c\n", *y);
    printf("Element ? = %c\n", *(y+1));
    return 0;
}
```

The program output shows: Element 1 = b

The explanation states: Here, the expression "y+1" returns the address 61, which is then dereferenced by * to return the value stored at 61.

Addr...	+ 0	+ 1	+ 2	+ 3	Variable
60	a	b	c		x
56				60	y
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Takeaway



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Visualizations can lead to improved learning outcomes only if accompanied by active learning strategies.

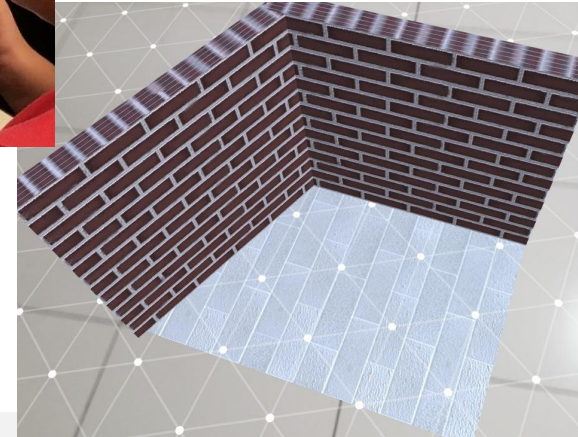


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Augmented Reality

What are our intended goals for using AR?

- Visualize 3D objects
- Rotate and view
- Measure angles in along various orientations
- ...

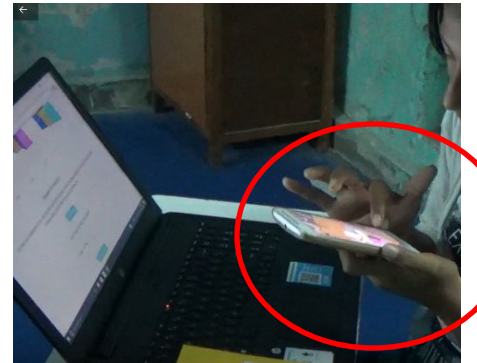
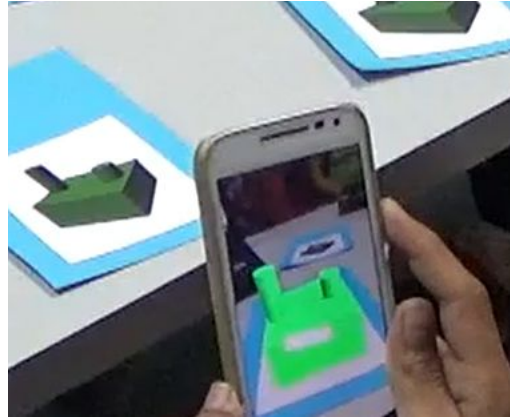


What does AR provide?

Affordances:

- Render 3D shapes
- Ability to rotate
- Ability to manipulate shapes

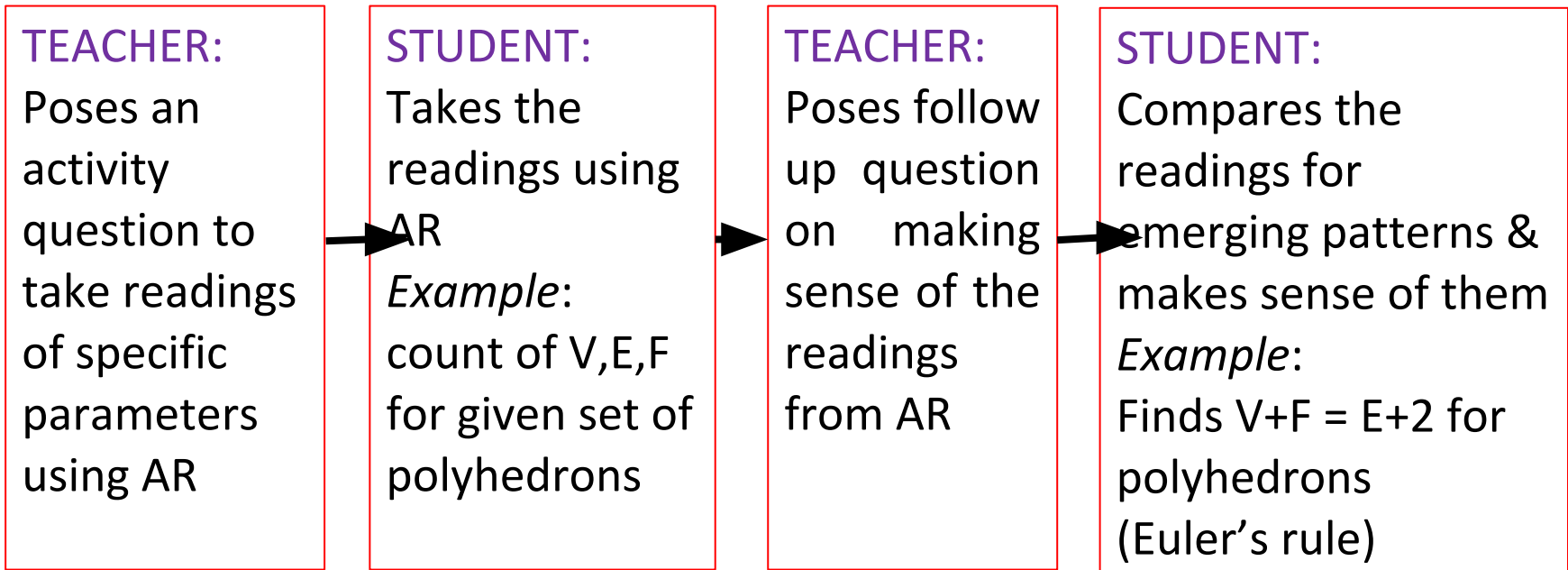
...





Active Learning with AR:

Basic Mantra : Do learner-centric activity using AR;
Do not leave their interaction with technology unguided

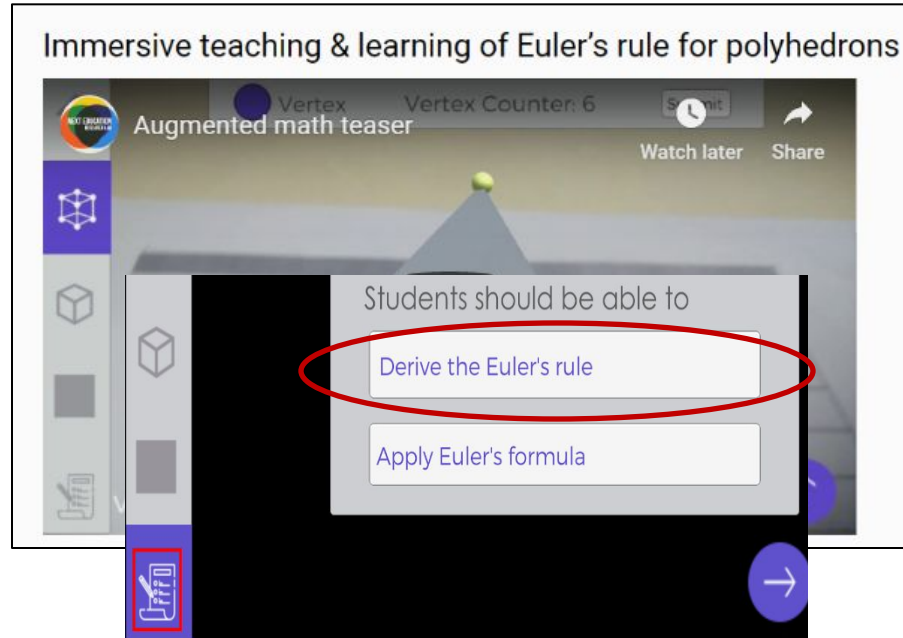


Active Learning with AR:

Recall from yesterday's demo :

Teaching-Learning activity
with *Augmented Math*

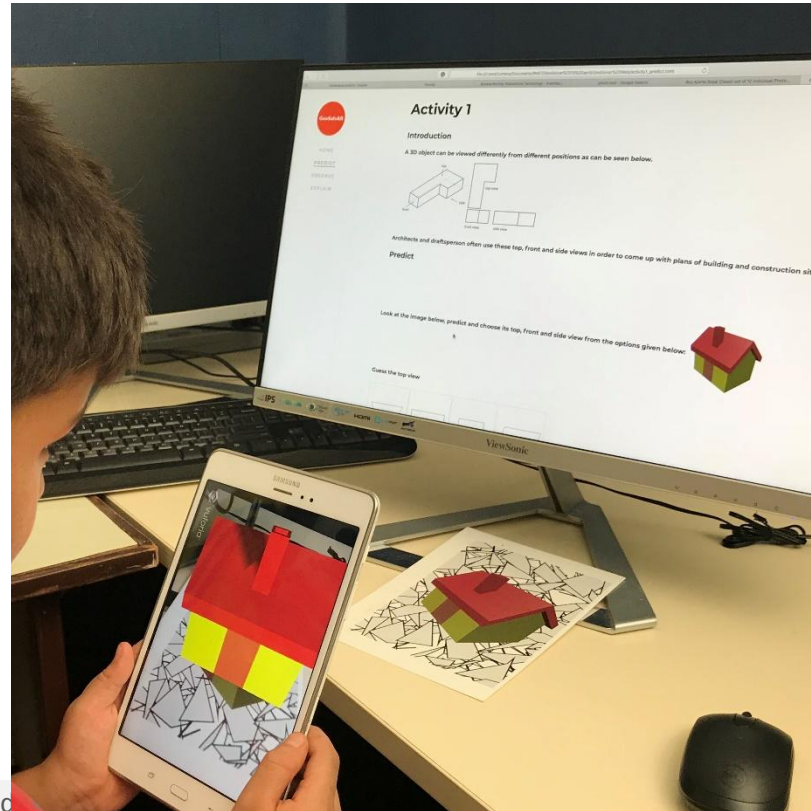
Inquiry Learning strategy



Active Learning with AR:

Learning activity with GeoSolvAR

Predict-Observe-Explain strategy



Active Learning with AR:

Basic Mantra : Do learner-centric activity using AR;
Do not leave their interaction with technology unguided

TEACHER:

Poses an activity question to predict output for given input parameters



STUDENT:

Makes the predictions.
Uses AR to verify their predictions from observations made with AR
Example: Top, Side, Front view of given object

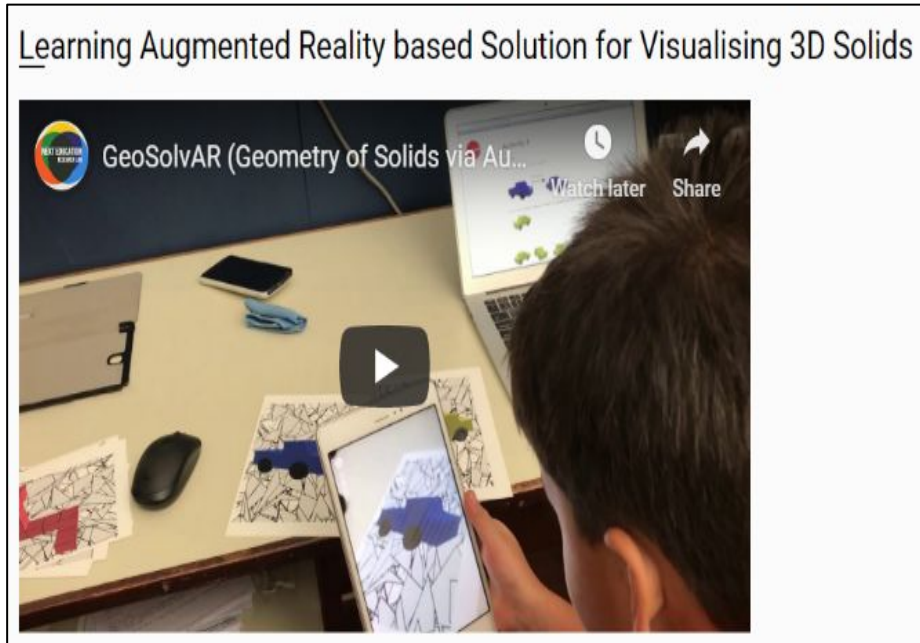


TEACHER + STUDENT:

Discusses explanation for their observations

Active Learning with AR:

Recall from yesterday's demo : GeoSolvAR



Pilot Study

8 participants, 5 activities each

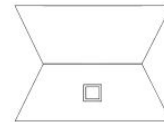
Audio and Video recordings,
interviews, QUIS
questionnaire, Pre-post test

Findings (usability):

- Perceived ease of use – high
- Students frequently used AR to rotate, while making prediction

Activity Type I

Look at the image below, predict and choose its top view from the given options below



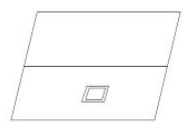
A



B



C



D



Design principles

Make sure design goal is clear:

Learning? Engagement? Efficiency? Accessibility? (not all the same)

Create pedagogical activities to harness technology affordance

Create a learning activity with focus question, requiring the use of tech

Use active learning during implementation

Students do activity, get feedback while exploring technology

Evaluate if initial goal is achieved



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Tea Break 😊



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Vote – Math Blaster game



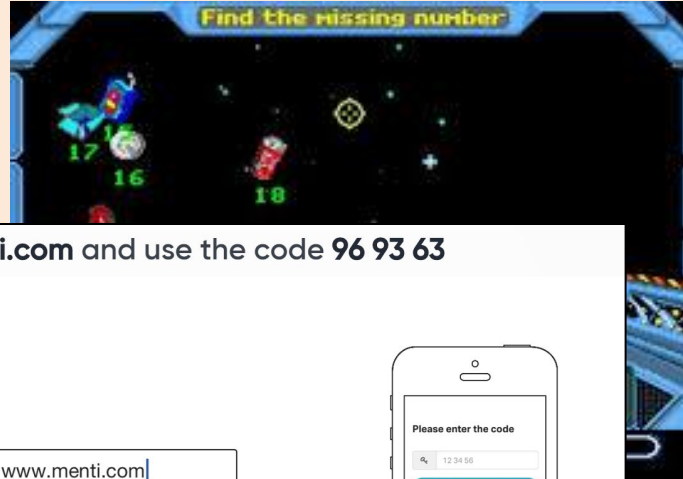
Vote – Math Blaster game



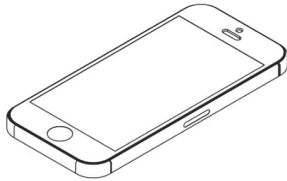
Is this an instance of effective integration of technology?

1) Yes 2) No

Vote – Math Blaster game



Go to www.menti.com and use the code **96 93 63**



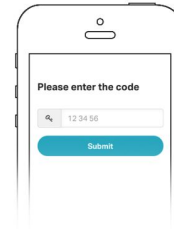
1

Grab your phone

www.menti.com

2

Go to www.menti.com



3

Enter the code 96 93 63 and vote!

Vote – Blood Typing game

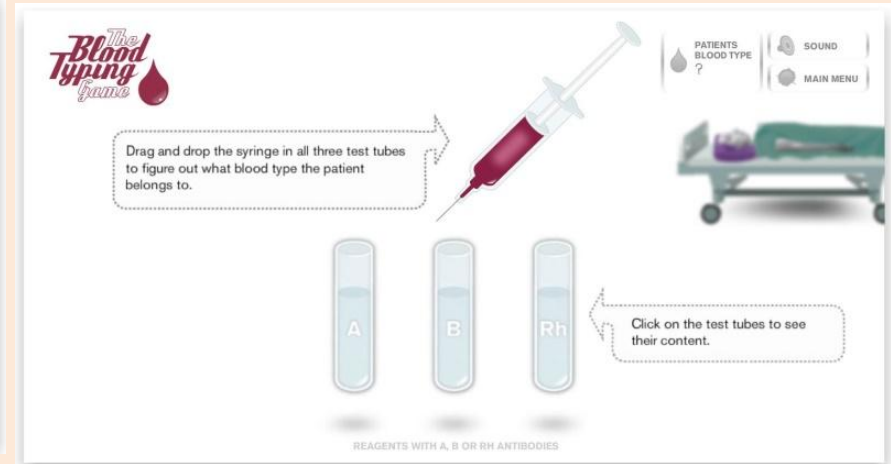


The Blood Typing game

Car crash victims

Hi and welcome to the emergency department at this hospital!
Your challenge is to save three patients who have been in a car accident and need blood transfusions. It is your job to blood type each patient and give them the correct blood. Try to avoid making mistakes or the patient's condition will deteriorate! If you make no mistakes you will get all five out of five blood drops in the end.

→ Proceed



The Blood Typing game

Drag and drop the syringe in all three test tubes to figure out what blood type the patient belongs to.

PATIENTS BLOOD TYPE ?

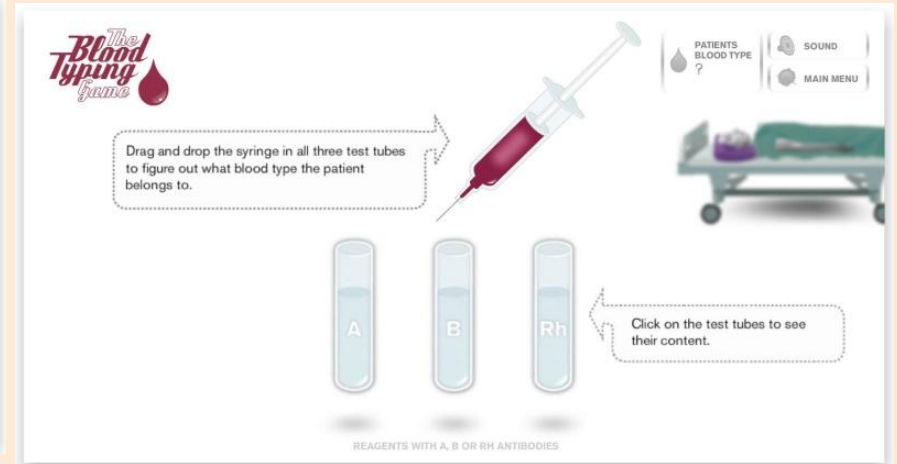
SOUND

MAIN MENU

Click on the test tubes to see their content.

REAGENTS WITH A, B OR RH ANTIBODIES

Vote – Blood Typing game



Is this an instance of effective integration of technology?

1) Yes 2) No



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Educational games



Analyzing computer games

Games contain:

Activity

Context

Rules

Competition elements

levels, points

People like games because:

Responsive

Interactive

Engaging

Fun

What makes an educational game effective?



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*

Takeaway



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META-STUDIES: Review 300+ studies on games –

Engagement – HIGH; Learning - MIXED

“Some games provide effective instruction for some tasks some of the time, but these results may not be generalizable to other games”

“...need to balance motivational elements with learning processes”

Takeaway



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Align game goal to learning goal

Make learning essential to game success

How to effectively integrate tech for learning



- What is the learning goal?
 - Avoid meaningless goals like “Teacher should use more of the new tech”
 - Avoid generic goals “Students should improve understanding”,
 - Be specific, for ex “students should determine blood type of patients”
- What is the affordance of the technology?
 - Determine what it *really* provides towards the above goal
- What should students do beyond watch, listen, push buttons?
 - vote, make predictions, draw concept maps, solve problem – using tech

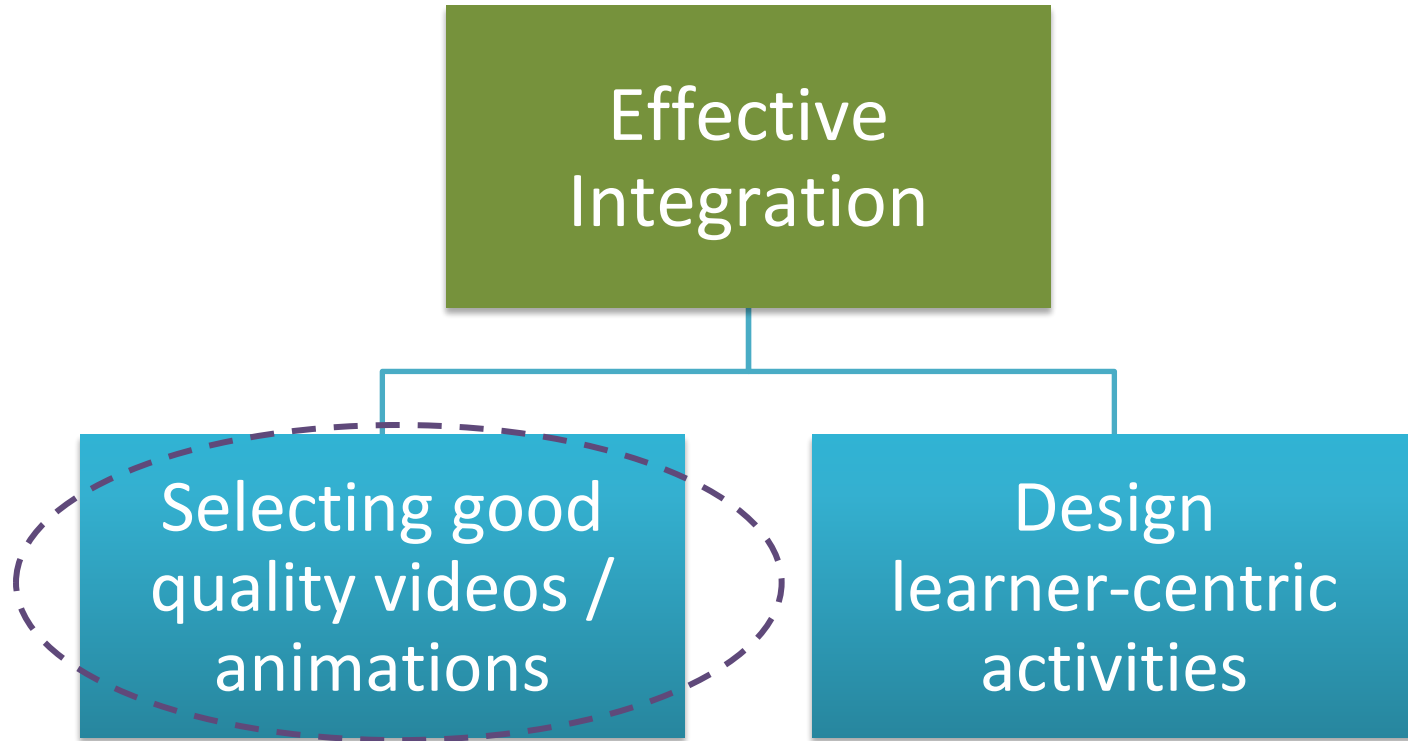


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How to select “good quality” technology-based resources?



Selecting good quality animation/videos





Think Phase

What you have to do :

Think phase (individually): Time – 2 mins.

- I am going to play 2 animations from <https://www.learnnext.com/cbse/class-7.htm>
- As you watch them, pick one
- Think & write down any 1 point you look for to decide if this video/animation is good for your students



Pair Phase

What you have to do :

Pair phase (group): Time – 2 mins.

- Turn to your neighbour
- Discuss the points you have come up with &
- Together come up with 3 points



Share Phase

What you have to do :

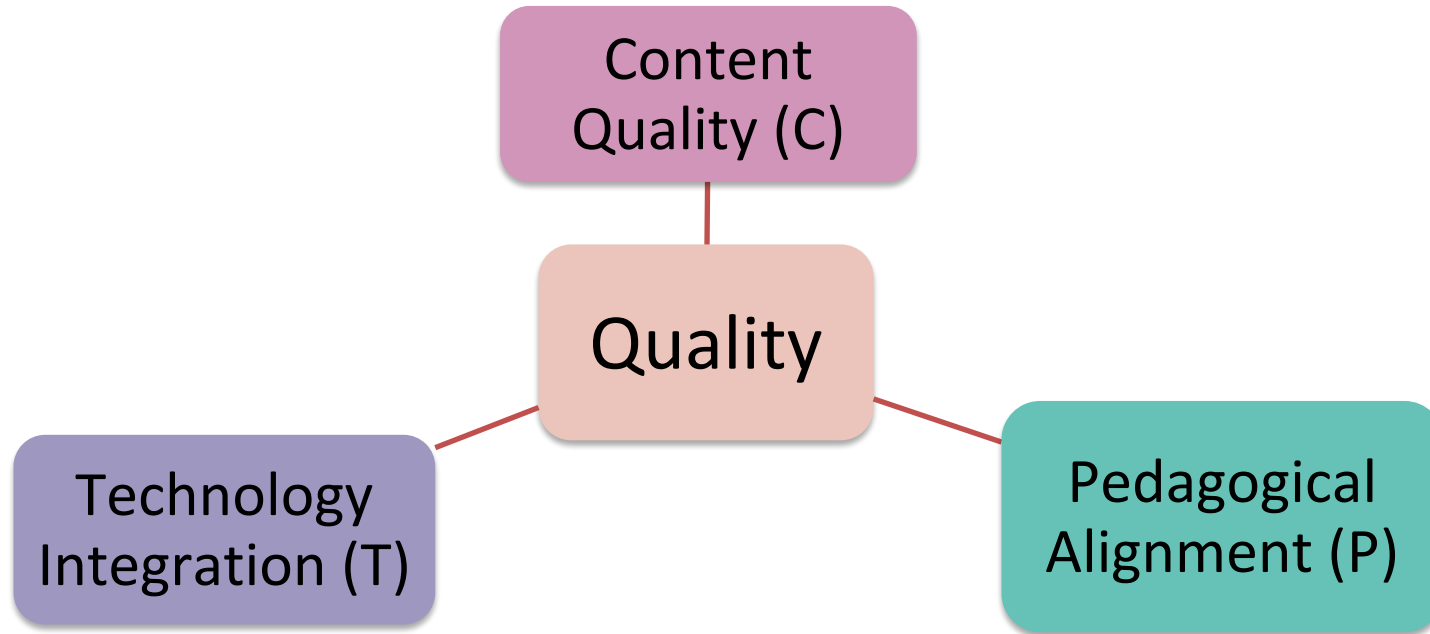
Share phase (whole group): Time – 5 mins.

- Share your points with all of us

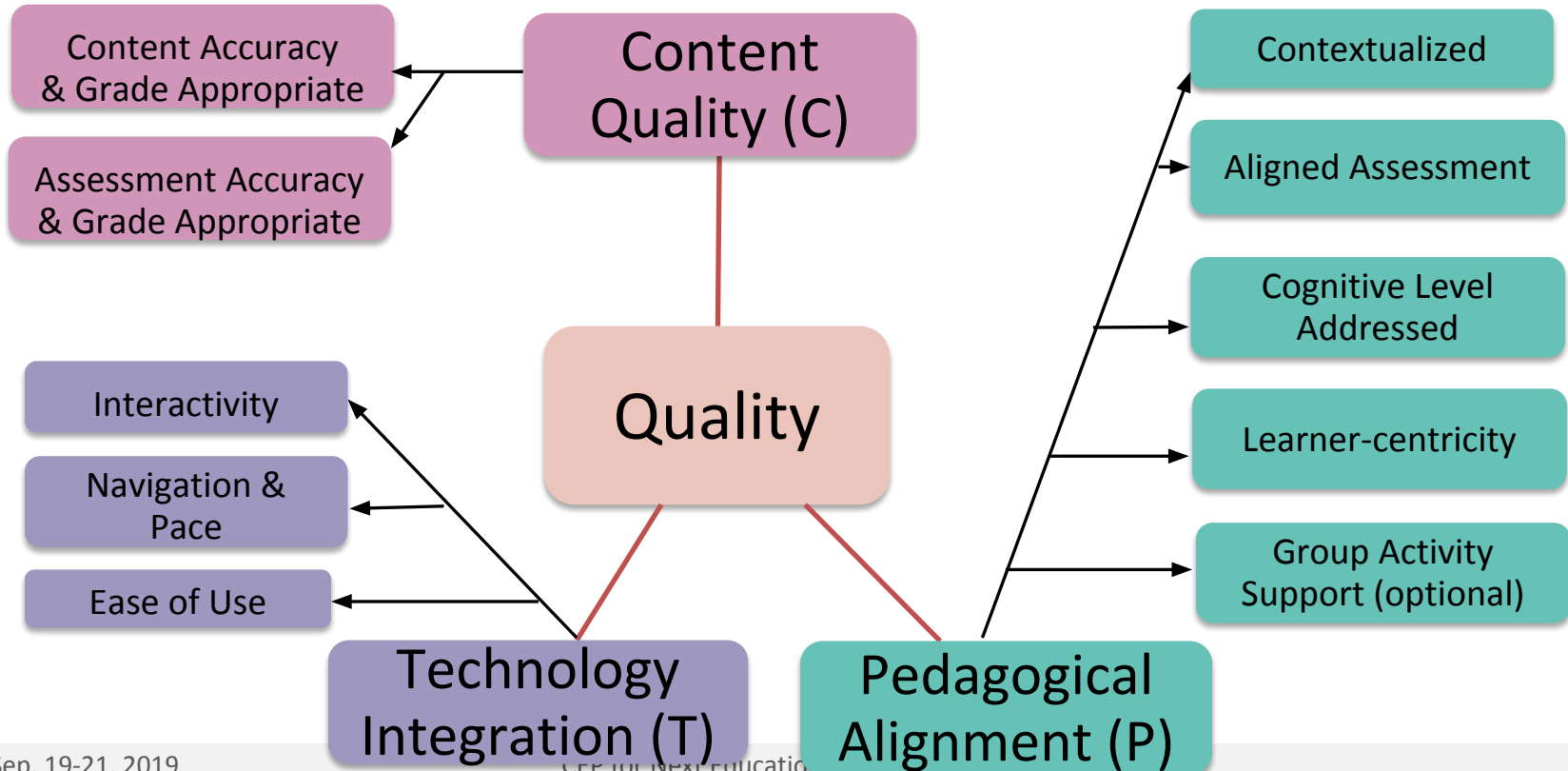
Quality Evaluation Constructs



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Quality Evaluation : Constructs & Criteria



LOBE_LITE : Learning Object Evaluation Instrument

<http://www.et.iitb.ac.in/labs/lobe.php>

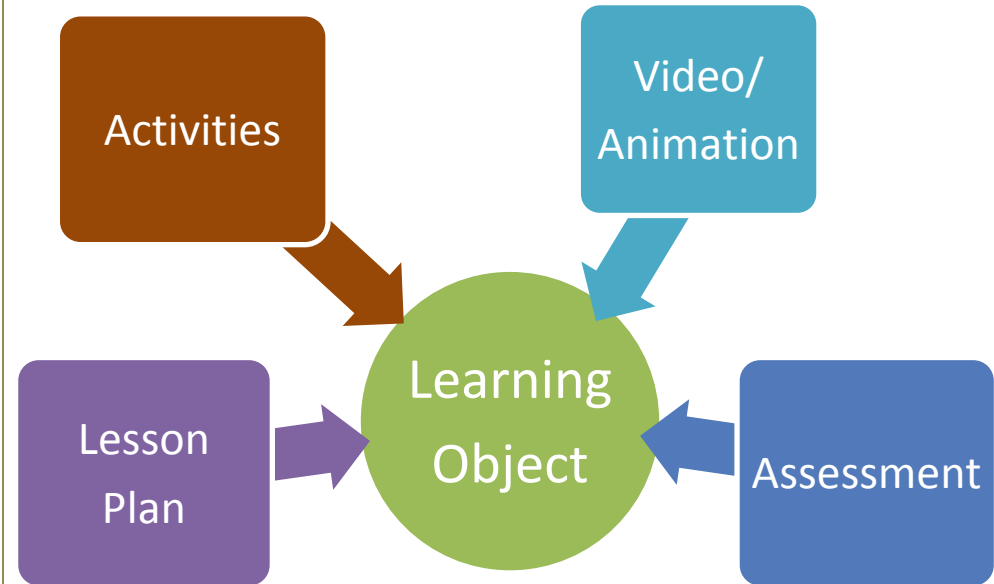
LOBE_LITE: Learning Object Evaluation Instrument (Abridged Version)

LOBE_LITE is a 4-scale (Missing, Inadequate, Almost, Target) theory-informed checklist for quality evaluation of learning objects. A learning object is a multimedia learning resource that contains dynamic visualizations (i.e. animations/simulations/videos) as its core component and either all or a subset of the following associated components – i) set of assessment questions, ii) learning activities, iii) solved examples.

Note: Please read the user manual from the webpage for a thorough understanding of how to use LOBE_LITE.

Content Quality (C)						
Questions	Score	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)	Remarks
C1. Is the content <i>accurate and grade appropriate</i> ?						
C2. Are the assessment questions in the learning object and their solutions correct, clear, unambiguous and <i>grade appropriate</i> ?						

Pedagogical alignment (P)						
Questions	Score	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)	Remarks
P1. Does the content and the assessment questions contain appropriate context?						
P2. Are the assessment questions in the learning object aligned to the stated learning objectives?						
P3. Has both higher order thinking skills (HOTS) and lower order thinking skills (LOTS) been sufficiently addressed in the learning object?						
P4. Does the learning object present						





LOBE_LITE : Learning Object Evaluation Instrument

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P3. Has both higher order thinking skills (HOTS) and lower order thinking skills (LOTS) been sufficiently addressed in the learning object?						
P4. Does the learning object promote						

Target Audience:
Principals, HODs, Teachers

<http://www.et.iitb.ac.in/labs/lobe.php>

LOBE_LITE : User Manual



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Content Quality Questions	What does 'this term' mean?	Which components to consider?	What is 'Target' for this question?
C1. Is the content accurate and grade appropriate ?	'Grade appropriate content' means - the content is appropriate for that grade. For example, introducing the 5 states of matter is grade appropriate for Grade 9 but not for Grade 5.	Consider the content across all components of the learning object like dynamic visualization, learning activities, examples, graphs if any etc. and score on the overall content accuracy.	The content contains correct facts, explanations, examples or graphical representations. The content presentation is unlikely to cause any misconception for the learner.



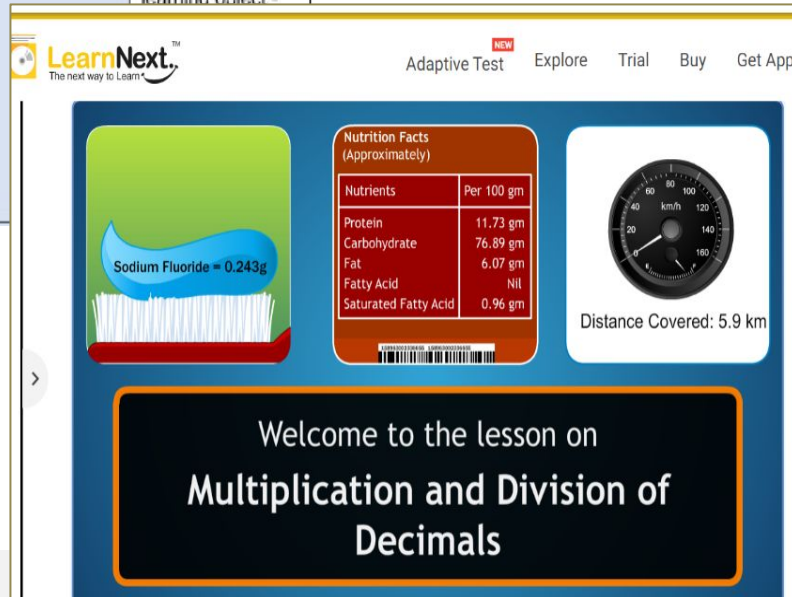
LOBE_LITE : How to Apply

What you have to do : *Individual activity*

- Take 2 criteria (P1 & P4) from LOBE_LITE &
- Observe demo for the explanation of their Target levels
- Watch the previous animation on 'Operations on Integers'
- As you watch, score it on P1 & P4
- Share your scores

How to apply LOBE_LITE : Activity

Pedagogical Alignment Questions	What does 'this' term mean?	Which components to consider?	What is 'Target' for this question?	Note before scoring
<p>P1. Does the content and the assessment questions contain appropriate context?</p>		<p>Consider the content in the following components of the learning object -</p>	<p>Context in content: The context should motivate the learner to care about the topic. For example, a motivational introductory scenario or a real life example or application of the topic.</p>	<ul style="list-style-type: none"> • Score on the overall quality of context provided. If you find contextualization completely missing in either one of content or assessment question, please mark as Inadequate. • Context is not required in all assessment questions. However, there should be sufficient questions containing a relevant and meaningful context.



The screenshot shows the LearnNext adaptive test interface. At the top, it says "LearnNext™ The next way to Learn™" and "Adaptive Test" with a "NEW" badge. Navigation options include "Explore", "Trial", "Buy", and "Get App".

The main content area features three panels:

- Left Panel:** A green box with a blue liquid drop containing the text "Sodium Fluoride = 0.243g". Below it is a barcode.
- Middle Panel:** A red box titled "Nutrition Facts (Approximately)" containing a table:

Nutrients	Per 100 gm
Protein	11.73 gm
Carbohydrate	76.89 gm
Fat	6.07 gm
Fatty Acid	Nil
Saturated Fatty Acid	0.96 gm
- Right Panel:** A white box containing a speedometer graphic and the text "Distance Covered: 5.9 km".

At the bottom, a dark blue box with a white border contains the text: "Welcome to the lesson on **Multiplication and Division of Decimals**".

How to apply LOBE_LITE : Activity



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Pedagogical Alignment Questions	What does 'this' term mean?	Which components to consider?	What is 'Target' for this question?	Note before scoring
P4. Does the learning object promote learner-centric learning?		Consider the content in the	The dynamic visualization and learning activities should allow learners to construct understanding of the topic	Give overall score on learner-centricity of the learning object.

The screenshot shows the LearnNext app interface. At the top, it says "LearnNext™ The next way to Learn™" and "Adaptive Test NEW Explore Trial Buy Get App". The main content area features a math problem: "The cost of a bike is Rs 50,000 and that of a cycle is Rs 10,000. The ratio of the cost of the cycle to that of the bike is ____." Below the problem is a basketball game simulation with a "SLAM DUNK!" graphic. On the right side of the simulation, there are five basketball icons with ratios: 1:5, 5:1, 2:1, and 1:2. A "HELP" button is visible at the bottom left of the simulation area.



LOBE_LITE : Demo of How to Apply

Pedagogical Alignment Question

What is 'Target' for this question?


P1. Does the content and the assessment questions **contain appropriate context**?

Context in content: The context should **motivate** the learner to care about the topic. For example, a **motivational introductory scenario** or a **real life example** or application of the topic.

<http://www.et.iitb.ac.in/labs/lobe.php>



LOBE_LITE : Demo of How to Apply

Pedagogical Alignment Question	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)
P1. Does the content and the assessment questions contain appropriate context?				



LOBE_LITE : Demo of How to Apply

Pedagogical Alignment Qs.

What is 'Target' for this question?


P4. Does the learning object promote learner-centric learning?

Animation/Video allow learners to **construct understanding of the topic on their own** by connecting the content to what they already know, organizing and making sense of the content, testing and revising their understanding, applying the content and so on. This can be promoted by providing **sufficient relevant activities** where learners are required to do the above. Such activities are essential in getting **learners engaged with the content** and for effective learning.

LOBE_LITE : Demo of How to Apply



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Pedagogical Alignment Question	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)
P4. Does the learning object promote learner-centric learning?				




LOBE_LITE : How to Apply

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- *Share your scores*




LOBE_LITE : Operations on Integers

Pedagogical Alignment Question	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)
P1. Does the content and the assessment questions contain appropriate context?				

LOBE_LITE : Operations on Integers



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Pedagogical Alignment Question	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)
P4. Does the learning object promote learner-centric learning?				

LOBE_LITE : Learning Object Evaluation Instrument



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LOBE_LITE: Learning Object Evaluation Instrument (Abridged Version)

LOBE_LITE is a 4-scale (Missing, Inadequate, Almost, Target) theory-informed checklist for quality evaluation of learning objects. A learning object is a multimedia learning resource that contains dynamic visualizations (i.e. animations/simulations/videos) as its core component and either all or a subset of the following associated components – i) set of assessment questions, ii) learning activities, iii) solved examples.

Note: Please read the user manual from the webpage for a thorough understanding of how to use LOBE_LITE.

Content Quality (C)						
Questions	Score	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)	Remarks
C1. Is the content <i>accurate and grade appropriate</i> ?						
C2. Are the assessment questions in the learning object and their solutions correct, clear, unambiguous and <i>grade appropriate</i> ?						

Pedagogical alignment (P)						
Questions	Score	0 (Missing)	1 (Inadequate)	2 (Almost)	3 (Target)	Remarks
P1. Does the content and the assessment questions contain appropriate context?						
P2. Are the assessment questions in the learning object aligned to the stated learning objectives?						
P3. Has both higher order thinking skills (HOTS) and lower order thinking skills (LOTS) been sufficiently addressed in the learning object?						

Introducing LOBE

Target User

Download LOBE


User Manual

Development Process

Robustness Testing

Download LOBE

Click on the list below to download the version of LOBE you want to use.

Name	Image	About Version	Download	Download Count
LOBE_LITE		<ul style="list-style-type: none"> LOBE_LITE is an abridged version of LOBE_PREMIUM consisting of 09-10 questions. It is a 4-scale (Missing, Inadequate, Almost, Target) theory-informed checklist for quality evaluation of learning objects. Use LOBE_LITE when you want to do a quick evaluation of the quality of the selected learning object. The robustness of the instrument cannot be vouched for. For thorough evaluation, use LOBE_PREMIUM (38 questions) that has been tested for validity & reliability. 	User Manual	24
		<ul style="list-style-type: none"> LOBE_PREMIUM is a 38-question rubric covering four dimensions. 	Rubric	16



Some Animation Repositories :

- LearnNext : <https://www.learnnext.com/>
- PhET : <https://phet.colorado.edu/>
- Wisconsin online : <https://www.wisc-online.com/learn>
- Visualgo : <https://visualgo.net/en>



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Thank you

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