MOTION

Overview of the module-

It has been observed that children have difficulties in learning about motion. Research studies show that they find concepts such as average, average speed, instantaneous and constant speed, the difference between the speed and velocity, acceleration, graphs of motion etc. difficult to comprehend. Moreover, they do not understand the context of learning motion.

The Clix chapter offered here tries to create a context for children to learn about motion. It has activities, riddles, thought experiment, control experiment, multi-representational digital tools and specific tools to analyze the data from an experiment.

It uses children's own knowledge to get into the topic and provide enough opportunity to reflect on what they are experiencing and learning.

Content Mapping with State Textbooks-

This clix chapter (TCC) on motion, maps the content of the chapter in our textbook titled as "**One dimensional Motion**". The main objective of this chapter has been to help children learn to describe and analyze motion in one dimension. We also call it linear motion.

There are additional pieces such as "measurement" and "graphs of motion", which are generally not found in the textbook chapter (TBC). But these skills are required to learn the concepts given in TBC and use them in a context. While testing the chapter we found out that children still face difficulty in these areas. That is why we have developed and included them in the chapter. You can use them as per your need of your children.

The chapter has been divided into separate conceptual units. The following diagram will help you see the concept flow of the TCC and relevant concepts of the TBC.

The title of the Clix chapter	**Concepts covered**
Measurement	Units of measurements, the need of a standardized scale, Errors in measurement, Average, Average speed, Data gathering, Data arrangements, Data Analysis
Riddles of Motion	Relative motion, the role of an observer, What is rest and what is motion?, The frame of reference, Qualitative understanding of how to describe and analyze motion?
Speed	Average Speed, Derivation of the equation avgV = Δd/Δt (**Average speed = Difference in Distance covered/Difference in time taken)** to cover the distance, its application, instantaneous speed, Constant speed
Distance and Displacement	The difference between Distance and Displacement, speed with Direction (velocity), Velocity
Graphs of motion	Plotting motion on graphs, understanding slopes, Position-time graphs, Speed-time graphs
Run Kitty Run	Calculating Average speed, time, position time graph, speed and time graph, relationship of motion on the

	track with graphs being visualized
How to figure out change in velocity	Uniform-non uniform motion, how to arrive at the definition of uniform and non-uniform motion in a given context, non-uniform motion of a ball on an inclined plane,
Acceleration	Acceleration, Acceleration of the ball on an inclined plane, Graps of the motion of the ball on an inclined plane, error in measurement etc, data analysis.

This comparison will give you a fair idea of how your textbook has a very close reflection in the clix chapter. It is just that the treatment and method is different.

Description of Lessons-

Lesson 1: Measurement

Note: Please read the student module. It will give you the idea of how to take it to students, when to intervene and when to help them reflect on their findings and learnings

Learning Objective

After going through this lesson, student will:

1. Be able to understand units of measurement
2. Be able to understand need for a standardized scale
3. Be able to understand errors in measurement
4. Be able to calculate average

Approach

Activity based:

1. Students will prepare a 2-meter-long tape using one sided waste paper, newspaper etc.
2. They will measure of distance of 10 meters using this tape. Will could their steps for this distance and then take the average.
3. The average length of one step now becomes their scale to measure various distances such as distance from school to home, from their class for Head master room etc.
4. Some, who have a wrist watch can also keep time to cover these distances. These data set can be used to work out average speed in steps/minute. 1.
5. Some, who have a wrist watch can also keep time to cover these distances. These data set can be used to work out average speed in steps/minute. **This can** be linked with "lesson 3: speed" to reinforce the need and method to calculate the average speed.

Once the tape is ready, you can encourage them the length and width of the school
ground, their classroom, their home, heights of their friends.

Error in measurement is an important concept in learning science. The foundation here will help them to understand its role in various tasks in their academic and day to day life.

You can ask them to compare the paper tape of one group with another. You can ask them to measure the earlier measured length again, you can ask them to measure the width of the blackboard again and again.
They may find it surprising that measurements numbers will change slightly.

You can ask them about the reason for this variance? Repeating measurement of a given length will give you value which is better than the last value. You can take them to the point that variance will exist. We can reduce the gap. That is why the need of taking an average comes out.

Lesson 2: Riddles of Motion

Note: Please watch the video and plan for discussions at appropriate place to reinforce the observation and learnings.

Learning objective

After going through this lesson, student will:

1. Be able to understand relative motion
2. Be able to understand frame of reference
3. Be able to understand the role of an observer

Important terms introduced

Please do remember that while learning science our focus should also be on introducing scientific terms that represents a concept and repeat these terms often.

Frame of reference
Relative motion
The role of the observer
Position

Approach

Idea of relative motion, Frame of reference and the role of observer are important concepts to help analyze motion qualitatively. These concepts require a fair amount of contextualization to build deeper understanding. We have used a set of videos to create a real context to bring these concepts to the fore. They are in the form of riddles.

Activity: Children will watch the video and teacher will conduct the discussion based on observation from videos.

Riddle1 - deals with the question “why don’t we feel the motion of the earth? It is to be read and discussed.

Riddle 2 – the discussion on it should move towards the relative motion of water with respect to the boat, change in position of the boat with respect to water, inability of any other reference point to figure out if the boat was moving or not?

Riddle 3 – the discussion on it should move towards the issue of defining rest and motion – how to define the state of rest or motion if both objects move in the same direction with the same speed or if they are stationary with respect to one another?

Riddle 4 – It brings out the role of the observer in describing an event. The video captures an event from two observer's perspective who are at different frame of reference with respect to each other and with respect to the event too. As the event appears to them differently they also describe it differently.

Lesson 3: Speed

Learning Objective

After going through this lesson, student will:

1. Be able to understand average Speed
2. Be able to understand derivation of average speed equation
3. Be able to understand constant speed
4. Be able to understand instantaneous speed

Important terms introduced

Delta
Distance
Time
Average Speed
Constant speed
Instantaneous speed

Approach

Material: A video in the student module

The lesson contains a video of a scooter ride, it has some information about the distance and time the rider takes to complete a journey. Students are supposed to discover this knowledge. This data set is further computed to derive the average speed equation.

There is a small assessment pieces attached with the first page of the lesson. This will help children to reflect on the data do some mental calculation.

Some teacher would like to use the blackboard to help children refresh the data that they have collected from the video. And also help them understand the assessment question if they are finding it difficult for some reason.

At the end of the lesson students should be able to learn about the Average speed, constant speed and instantaneous speed.

Link it with lesson 1- paper tape activity Data: Using the average speed formula, you children now can use the data set generated in the lesson 1 exercise to compute their average speed to reach school from home. you can further discuss with them the reason for this speed varying nearly every day.

Lesson 4: Distance and Displacement

Learning objective
After going through this lesson, student will:

1. Be able to understand distance
2. Be able to understand displacement
3. Be able to understand the difference between distance and displacement
4. Be able to understand velocity

New terms used in this lesson
Magnitude
Direction

Displacement
Velocity

Approach
Material: to be done on the computer; children will work in pairs to complete this section

This part is more on the applied side, elaborating 'what is distance?" and "how does it differ from Displacement?". Children will use computer for this part.

Velocity has been elaborated here in detail. There are animated examples to help children to visually understand what it means when we say velocity is "speed with direction"

Context have been built where velocity has been worked systematically out of a given problem.

Lesson 5: Graphs of Motion

Learning Objective
After going through this lesson, student will:

1. Be able to understand how motion is plotted on a graph
2. Be able to understand position-time graph
3. Be able to understand speed-time graph

New terms used in this section
Axis
X axis
Y Axis
Position
Slope

Approach

Material: handbook to be done in the class. If you want to do it on the computer, students should work in pairs. They should also use their notebook while working on the computer.

Graphs are a most important tool is science to display information.

In motion we display motion in two types of graphs – Position-Time graph and Speed/Velocity-time graph. the first one helps us see how position of a moving object is changing with respect to time. In the second we get to see how speed is changing with respect to time.

We have well described event in the module around which graphs have been built. In some children will find out the missing data after reading the slope and in some they will use the data to fill up the missing slope piece on the graph.

You can use it to revise the graph learning with students, which is essential to learn anything about motion. They should be able to read the slope easily and say what type of motion it represents.

Graph literacy also helps them in learning about equations of motion.

The section has some assessment pieces too. They will help teachers learn whether children have developed a grasp over the concept or not.

Lesson 6: Run Kitty Run

Learning objective

After going through this lesson, student will:

1. Be able to understand relationship between distance, time, and speed
2. Be able to understand position-time graph
3. Be able to understand speed-time graph

It is a two-player game. You should allow the children to explore the game on their own to play it.

Lesson 7: How to figure out change in velocity

Quantitative understanding of Motion
New terms
Uniform motion
Non-uniform motion

In this part of the chapter we try to understand uniform and non-uniform motion. These are fundamental entities helping us to categorize any motion. We need a precise set of quantities to help us describe a motion as uniform or non-uniform.

When we say quantity – we mean data, numbers for calculation, analysis. them It helps us look for some pattern and move towards theory formation.

Till now we have discussed to analyze and describe manner in a qualitative manner. We know that we need position and time both to be able to describe the motion.

If we want to say precisely about motion of an object, we should be able to able to record its change in position and time taken in moving from one point to another.

We use a real-life example here:

A. A short sprint – minimum 24 meters, max 60 meter.
B. A bicycle rolling down the slope.

Preparation: a teacher need to prepare for the activities. The material needed here is as follows;

1. Set of stopwatches – 4 per group; they can be rotated among different groups. In case there are no stopwatches in the school – please use your mobile phone. Normally all mobile phones have stopwatch app with lap recording. You can also take the help of another teacher to manage more group of children this way.

2. Form a group of at least 6 children, give every group a name. this way identification becomes easy if you have large number of children.

3. Roles – before they start the activity – please explain to them and one child will become the record keeper with table to record the data. 4 will stand on the four segment points of the running track – they will be called the time keepers. And one runner will run. All children will have to run. Therefore, once the first person's race is over, she will replace one of the 5 members from their assigned role and take their role. At the end of activity every child would have played the role of time-keeper, record keeper and the runner.

Every child will run for minimum three times.

4. Table to fill up the data – the table is given in the student handbook. Please ask every child to make it in their notebook.

Name	0 meter.	12 meter.	24 meter.	36 meter	48 meter.
Runner 1 Run 1 Run 2 Run 3	 0 sec 0 sec 0 sec	…sec.	…sec	…sec	…sec
Runner 2 Run 1 Run 2 Run 3	 0 sec 0 sec 0 sec	…sec.	…sec	…sec	…sec

Runner 3 Run 1 Run 2 Run 3					
Runner 4 Run 1 Run 2 Run 3					
Runner 5 Run 1 Run 2 Run 3					
Runner 26 Run 1 Run 2 Run 3					

5. Place arrangement – you need a place for children to run. A minimum length of 24 meter will work – please ask children to measure it and divided into four equal parts and mark these points.

Children should be given some time to practice with stopwatches.

Work in the classroom

The first session of this chapter begins in the class.

You would present them with the following scenario ask them to write their answer answers in their notebook. This answer will become a reference point for them to compare their finding from the activities;

1. Suppose you are running a 60-meter race. Could you try to imagine how would you run this race from start to finish? With the same speed? Will you speed vary? How will it vary?
2. If you rolling down a bicycle on the slope, without pedaling, if the motion of bicycle change or not? If no, why? If yes, how from start to finish?

Then they will conduct the activity.

First the running race activity. Using the data, they can plot their position-time graph and compare each other's slopes. They can also work out the average speed for each segment and compare which one was faster in which segment? whether anyone has the same average speed in each segment or in every segment the average speed was varying?

You can ask them to compare their assumption about the way they run with the real time data? How does it differ? Can they say now confidently now about the nature of their run? What helped them – data?

Children may come to the conclusion that their motion on the track was non-uniform. Data tells them so. Without data we could not have described this motion precisely.

Similarly, many of the real-life motion events are non-uniform in nature. But only way we can conclusively say about them if either break the whole motion path in smaller equal segments and take the time or if record the distance covered in every second? Please emphasize on this method to be used to describe motion in detail.

The smaller the segment the more conclusive our description would be.

Bicycle rolling down the slope

It will be very difficult to get a real time data of the bicycle on the road. Here we introduce the concept of control experiment.

The aluminum rod becomes the road and a marble/steel ball becomes the bicycle.
Children will divide the distance into 5 segments of 30 cm each and then will take record the time to cover each segment.

If you have 5 stopwatches

If you have 5 stop watches then like run the entire activity can be done in one go. One person will leave the ball while 5 timekeepers will record the time as the ball passes from each segment.

If you have 1 stopwatch
If you have one stopwatch. One child can drop the ball while the other can record the time, one by one for different segments.

They fill the data in their notebook. The format is given in their student handbook.

They will process the data, work out the average speed for each segment and then try to describe the change in motion using this data.

Maybe they describe that speed of the ball was increasing as the ball was rolling down the plan?

Compare it with running race activity:
In running race, the average speed was varying unevenly – in some it was high, whereas in some it was slow, whereas in the rolling down the speed was getting gradually higher. Both are examples of non-uniform motion.

Lesson 8: Acceleration

New terms
Change in motion/speed over time

Before we start the acceleration, let's be clear – it is one of the most difficult topic for children to understand in this section. We need to deal with it carefully.

Children are generally familiar with the term, accelerator, as they use it often in the context motorbikes or vehicles. In Chhattisgarh, children responded by saying that accelerator is used to give race to the vehicle.

Race means change in speed.

You can also ask them what happens when there is a sudden change in speed – increase or decrease, race up or race down? they share their experience of jerking forward or backward from their siting position.

Then you talk to them about a situation such as follows: you are on a bus going at a constant speed/motion. For 10 minutes it goes like this, then suddenly the driver speeds up, the speed change goes for a minute, then again, a 10 minutes' patch of smooth ride, then again one-minute patch of sudden speed down.

In dealing with acceleration we are interested in those parts of the motion where there is change in speed/velocity.

One of the major problem are for children is how to compute acceleration and why does it unit have time coming twice.

So stepwise that is how we should progress

1. Help them figure out how do we feel acceleration and what happens with respect to the speed at those points
2. Use the video and clock to help them understand that we are concerned about the change in speed in given interval of time. Speed is already a ratio/rate of distance over unit time. Acceleration is a further rate of – distance over time over time.
3. Initially you help them understand km/h/minute (using video); meter/minute/sec

4. Then brings them to the unit which is generally used – meter/sec/sec which is also written as meter/sec^2.

Here we are generally using examples of uniform acceleration for children to first help understand and able to calculate it easily.