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An Investigation Into Students' Alternative Frameworks About THe Concepts Of Mechanics

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Abstract: A study of investigation into students' alternative frameworks about the concepts of mechanics was conducted on groups of students of schools and colleges. Accordingly, different groups of students (plus two (+2), undergraduate (UG) and graduate (G) levels) were examined by administering questionnaire followed by practical activities and personal interview sessions. The questionnaire was administered on randomly selected heterogeneous group of students. Four practical activities related with concepts of mechanics were designed. Randomly selected groups of students from each level were asked to perform these activities and identify specific concept behind a particular activity. Diagnostic structured and individual interview was conducted to supplement the test administered and to reveal the rationale behind giving particular response to a question. The analysis of responses depicted that students are in possession with alternative frameworks about the concepts of mechanics.

Key words: Alternative Frameworks, Concepts of Mechanics and Constructivism in Physics Education.

INTRODUCTION :

A lot of studies have been carried out to know "How Pupils Learn Physics". Many research studies on this subject focus on what may be called as 'preconceptions' and Misconceptions', Pre-concepts are everyday experiences. Common sense theories, array of explanations, beliefs, native world view and interactive knowledge or present status of knowledge by means of which the learners' make their own sense of environment they observe and experience. These have also been referred as Alternative Frameworks (1-30). Good has suggested labeling all such conceptualizations or beliefs to be 'Pre-Scientific Conceptions' in an effort to bring coherency of thought among physics learners. When learners hold views which differ from conventional scientific explanations or classifications they are often referred to as alternative frameworks or children's ideas (Collins Concise Dictionary). Exploration of alternative frameworks of various concepts of physics among students at various levels has been of much interest during last few decades (1-31). This is especially important from the view of successful teaching. For a prior knowledge of the alternative frameworks among students can be the basis for generating discussion and planning of strategy to help the students acquire the correct concepts and also make them think in a scientific way. It is, therefore, necessary to determine such alternative frameworks before starting any teaching – learning process pertaining to concepts of Mechanics. Concepts of mechanics are very fundamental in basic physics. Its effects are distinctly perceptible in dynamics, gravitation and other branches of physics. Keeping aforesaid in view, we have examined different groups of students using mechanics base line test (MBT) (6). This test (MBT) was administered over students at different levels of learners (comprising +2 level, I year B.Sc.B.Ed., II year B.Sc.B.Ed, III year B.Sc.B.Ed, IV year B.Sc.B.Ed, I/II year B.Ed. and M.Sc. students) of schools and colleges of Ajmer district of Rajasthan state followed by four practical activities (No. I to IV) related with aforesaid concepts of mechanics. Students were asked to perform practical activities and identify the specific concept behind a particular activity. Also they were requested to write reason for identifying the concept behind a particular activity. Interviews of randomly selected students were audio and video graphically recorded. Later on transcription was done and inferences were drawn using all the aforesaid data. A brief review about learning, learners' characteristics and their ideas is given below:

CONTRUCTIVISM IN PHYSICS EDUCATION

During last few decades constructivist view of learning has got much attention in the physics education (1-31). This view is based on the constructivism which is a theory of learning and a theory of knowing. In this theory, learners construct their own knowledge of the world through experiencing things and reflecting on those experiences. Knowledge is a construction of reality rather than behaviours or skills as the goal to instruction. In this paradigm, learning emphasizes the process and not the product. Learning is not viewed as passing transfer of knowledge but learner actively constructs his knowledge on the basis of knowledge already

held. Teachers' role is not to dispense knowledge but to provide learners with opportunities and incentives to build it up. The teacher is, therefore, a facilitator and the learner a sense maker (http://www.ncert.nic.in). Guiding principles of constructivist approach are given below:

It emphasis on learning and not teaching,
Learning is an active process,
Learning is the result of mental construction,
Children have their own language to construct the knowledge,
Teaching methodology is based on personal construct theory,
Children's theories are tentative,
Learning is a social activity and
Learner learns to learn as she/he learns.

CHARACTERISRICS OF THE LEARNER

Some teachers hold the idea that learners' minds are vacuum and hence it can be filled up with information. Their minds are like clean paper and anything can be engraved on it. But it has been observed that when new concepts are introduced in the class and learners are asked about it, they reply in their own way using their mini theories. Learners construct their knowledge themselves when they come across new experiences of environment. They go on modifying these when they encounter new situations (16).

Following characteristics of the learners are suggested:

Learners know a lot of physics.
Learners are physicists.
Learners have Mini-theories of their convenience.
Learners learn when they realize that their existing theories are inadequate.
Learners' mini theories vary in their commitment.
Learners apply different mini theories at different time in similar situation.

LEARNERS' IDEAS

A large number of studies have been conducted to know learners' ideas (1-31) about various concepts/ phenomena of physics. The techniques (1-31) used for this purpose are briefly discussed below:

PAPER PENCIL TEST

A large number of studies have been conducted using paper and pencil test with some variations. In its simplest form, it consists of a set of multiple choice type questions. The response to these questions forms the basis of analysis. A common variation of this requires respondents to write down an explanation of the selected response for each question, which is used to identify the existing alternative framework.

INTERVIEW

In some form or the other, interview has been used quite often to identify alternative frameworks. One common form of this is the interview about instance (IAI) approach. This involves interview on a set of line diagrams, which the interviewers are required to interpret as an example or non-example of concept in question. Learners are required to explain their point of view through probing questions. The interview is initially in the structural form but the researcher may pursue to a particular point that may arise during the course of interview.

CONCEPT MAP

Concept maps are line diagrams initialing relationships between the concepts. Concept may be regarded as regularities in objects designated by some level usually. Whether a process, procedure, or a product, concepts are what we think within physics. Concepts can be connected with linking words to form propositions. These maps can be utilized for evaluating understanding of the concepts of physics.

COMPOTER TASK

Computers have been used for understanding the nature of learners' concepts and for instruction. Computer videodisc system has been used by Goldberg to conduct interview of students. The basic advantage is that the same system can be used as teaching aid also.

INFORMATION COMMUNICATION TECHNO LOGY (ICT)

ICT is an important component of physics education and its potential applications can be employed to investigate students' understanding regarding particular concept of physics. Internet websites may be exploited for information and knowledge of various issues in the field and approaches towards them (http://www.ncert.nic.in, http://www.alltheweb.com,http://www.altavista.com, http://www.school.discovery.com, http://www.teachervision.com, http://www.education-world.com) (3).

LEARNERS' STATEMENT

Research studies indicated that statements of the learners can be taken up as a reaction to learners' understanding (16). Teacher's observation during teaching learning can also give a chance to observe common misconceptions/ alternative frames among the learners.

HYPOTHESIS

To conduct this study following hypotheses were proposed:
Learners already have knowledge of concepts of mechanics before coming to the classroom.
Learners are in the possession of different mini- theories and these mini- theories are very dear to them.
Learners keep on changing and proposing new mini- theories on encountering in unfamiliar situations. These mini-theories are inconsistent and the peer group and other members of community influence learners' understanding.
This situation of possession of theories by learners is advantageous to the teacher, as she /he need not to start from the vacuum. It facilities in accepting, rejecting or modifying the knowledge structured in the learners' mind.

OBJECTIVE OF THE STUDY

To identify the alternative frameworks of the students regarding concepts of mechanics and
To suggest ways and means for eradicating the alternative

frameworks.

DESIGN OF THE STUDY, SAMPLE AND PROCESS

Mechanics Base line Test (MBT) is a questionnaire (6) having multiple-choice questions related with the concepts of mechanics viz. kinematics (linear motion; constant acceleration, average acceleration, integrated displacement and curvilinear motion; tangential acceleration, normal acceleration), general principles (first law, second law, third law, superposition principle, work-energy, energy conservation, impulse- momentum and momentum conservation) and specific forces (gravitational free-fall and frictional force). Each question of MBT is having five multiple-choice options. Out of five options one is correct and remaining four are having suspected misconceptions in each question. The tool (MBT) was administered on a heterogeneous and random group of students at different centers having well equipped facilities and devoted staff's dealing with physics education. Students were directed to opt correct options and write their reasons for opting them from multiple-choice questions. At the next stage of the study four practical activities (No. 1 to 4) related with concepts of mechanics were designed and randomly selected group of students from each level was asked to perform these activities and identify specific concept behind a particular activity. They were also asked to write the reasons behind the identified concept involved in a particular activity. Diagnostic structured and individual interview was conducted in a friendly atmosphere to supplement the written test and to reveal the rationale behind giving particular answer to a question. The proceedings were recorded audio and video graphically. The recorded version of the interview was analyzed. Answers of the written test and interview were co-related to draw the conclusions. The sample (Table- 1) consisted of +2 students, Undergraduate (UG) students at different levels, Graduate (G) students and Postgraduate (PG) students.

Table- 1 Details of the sample

S. No.	Type	Size	Level
1	+2 students	83	+2
2	B.Sc. B.Ed. I year students	20	U.G.
3	B.Sc. B.Ed. II year students	25	U.G.
4	B.Sc. B. Ed. III year students	25	U.G.
5	B.Sc. B.Ed. IV year students	26	U.G.
6	B.Ed. I/II year students	23	G
8	M. Sc. students	30	P.G.

ACTIVITIES DESIGNED

Four practical activities (No. 1 to 4) based on different concepts of mechanics viz, kinematics (linear motion; constant acceleration, average acceleration, integrated displacement and curvilinear motion; tangential acceleration, normal acceleration and a = v2/r), general principles (first law, second law, third law, superposition principle, work-energy, energy conservation, impulse-momentum and momentum conservation) and specific forces (gravitational free-fall and frictional force) were designed. Students were asked to perform these activities and identify the concept involved in each activity. They were also instructed to write their reasons for identification of specific concept involved in a particular activity.

Activity No. 1 was related with the concept of linear motion. Students were expected to investigate the concept of linear motion with constant acceleration, constant velocity, integrated displacement and type of motion. A plane tabletop, an aluminium Channel 3.0m long (half of its length was inclined with the table top and remaining half was kept parallel to the table top). Two steal balls of different diameters; a scale and a stopwatch were provided to the students to measure displacements and time.

Activity No. 2 was related with the concept of motion and conservation of energy. In this activity students were provided four balls of different materials viz, steel, aluminium, wooden, brass and copper) of identical diameter, an aluminium channel of a total length 2m. The aluminium channel was bent in 'V' shape as shown in the photograph. Students were expected to investigate the motion of different balls along with energy conservation aspect. A scale and a stopwatch were also given to measure displacement and time respectively.

Activity No. 3 was related with the general principles (first law, second law, third law) of mechanics. Students were provided dynamic wooden cart, different weights, two blocks of glass, a wooden block, a spring

balance, thread and a smooth wooden surface of a tabletop. They were asked to investigate the concepts related with first law, second law and third law of motion.

Activity No. 4 was related with the concept motion and specific forces. Students were provided four objects made up of steel of different geometry (prism shaped, cuboid, spherical and cylindrical) and an inclined plane, a stopwatch, a smooth surface of tabletop and a scale.

After performing aforesaid activities (1 to 4) students were interviewed audio and video graphically by asking structured and cross-questions. They were also asked to write the reasons behind the identified specific concept involved in a particular activity. Some of the extracts of the transcriptions of interviews and written answers (Tables-2-5) of the students are given below:

EXTRACTS OF THE INTERVIEWS

Student – 1

T.The branch of physics which deals with motion and forces producing motion is termed as - - - - - - - - - - - -?

S.Kinematics.

T.What is kinematics? Is there any difference between kinematics and mechanics?

S.In kinematics motion of different objects is studied and observed. Kinematics is same as mechanics?

T.What in your opinion is caused by force?

S.Force causes displacement in body and produces velocity and velocity causes acceleration.

T.How force is related with motion?

S.Force is directly proportional to acceleration and mass of the body.

T.How many types of force and motion you encounter in your daily life?

S.Frictional force, linear motion and motion on inclined surface.

T.Constant force results in constant velocity or average velocity or uniform velocity or any other?

S.Constant velocity.

T.Distinguish between linear motion and curvilinear motion and cite three examples of each type of motion?

S.Linear motion is motion along a line and motion on inclined surface is termed as curvilinear motion. Example of linear motion is walking and example of curvilinear motion is kids sliding on inclined surface.

T.What will be the nature of the graph (V vs T) if body has got constant acceleration?

S.Straight line graph.

T.How do you distinguish between normal acceleration and tangential acceleration?

S.Normal acceleration – gravitational motion, tangential acceleration - No response.

T.During storm a fruit and a leaf are separated at the same time from the tree. Do they reach the ground at the same time?

S.Fruit – falls fist as weight is greater.

T.Moving bodies do work. Comment on it?

S.Work = force × displacement

T.What did you infer after performing activity No.1 and why?

S.The motion the ball depends on the material and weight of the body (ball). The heavier body (ball) reaches ground first.

T.What did you infer after performing activity No.2 and why?

S.Motion of different objects on the inclined surface. The motion of the ball is linear and curvilinear both. On plane surface motion of the ball is linear. Energy and momentum remains conserved in all cases.

T.What did you infer after performing activity No.3 and why?

S.Body moves when force is applied. All the three Newton's laws of motion are applicable in this activity. Motion of the body depends upon the weight applied.

T.What did you infer after performing activity No.4 and why?

S.This activity is based on curvilinear motion. Frictional force depends on shape of the object. It is greater in case of prism like object. In case of spherical ball frictional force least. Frictional force does not depend on contact area.

Student - 2

T.What is mechanics?

S.It deals with force and study of motion (any body moves).

T.What in your opinion is caused by force?

S.As we apply force the body moves.

T.Do you think motion necessarily means presence of force?

S.Yes, because as we apply force body moves.

T.How force is related with motion?

S.F=m (dv/dt).

T.How many types of force and motion you encounter in

your daily life?
S.Linear motion and curvilinear motion and frictional force.
T.Constant force results in constant velocity or average velocity or uniform velocity or any other?
S.Constant velocity.
T.Is it always true?
S. This is always true.
T.Distinguish between linear motion and curvilinear motion and cite three examples of each type of motion?
S.Motion in straight-line – linear motion example – motion of train, curvilinear – motion of satellite and planets?
T.What will be the nature of the graph (V vs T) if body has got constant acceleration?
S.Straight line graph.
T.How do you distinguish between normal acceleration and tangential acceleration?
S.Normal acceleration: Rate of change of velocity, Tangential acceleration body moves on circular path.
T.During storm a fruit and leaf are separated at the same time from the tree. Do they reach the ground at the same time?
S.In air fruit reaches first.
T.Moving bodies do work. Connect on it?
S.W=F×d as ball moves on the surface. It covers certain distance. No work is done if motion is not there.
T.What did you infer from activity No. 1 and why?
S.Newton's second law as acceleration decreases with increase in mass.
T.What did you infer after performing activity No.2 and why?
S.Energy conservation.
T.What did you infer performing activity No.3 and why?
S.All three laws of motion are applicable in this activity.
T.What did you infer after reforming activity No.4 and why?
S.Motion and frictional force of object depends on its shape. Friction is least in the motion of spherical ball and maximum for square shaped object.

Student - 3

T.What is mechanics?
S.Study of velocity, acceleration and about motion?
T.What in your opinion is caused by force?
S.Force changes position, velocity and acceleration of a body.
T.Do you think motion necessarily means presence of force?
S.Yes, if force is not present on an object, motion will not be there i.e. state of rest according to Newton's I law.
T.How force is related with motion?
S.Force is proportional to motion.
T.How many types of force and motion you encounter in your daily life?
S.Frictional force and rolling motion, sliding motion while.
T.Constant force results in constant velocity or average velocity or uniform velocity or any other?
S.Uniform velocity.
Q.Distinguish between linear motion and curvilinear motion and cite three examples of each type of motion?
S.Motion along straight-line –motion of train and curvilinear – motion along curved path.
T.What will be the nature of the graph (V vs T) if body has got constant acceleration?
S.Straight line graph. In this change in velocity and change in time are constants?
T.How do you distinguish between normal acceleration and tangential acceleration?
S.Normal acceleration: Motion along straight line, Tangential acceleration - Motion along tangent to a particular point.
T.During storm a fruit and leaf are separated at the same time from the tree. Do they reach the ground at the same time?
S.No they do not reach at same time as mass is not same in both cases.
T.Moving bodies do work. Connect on it?
S.As ball moves. It covers a distance therefore some work is done.
T.What did you infer from activity no. 1 and why?
S.Heavier ball takes less time to cover a distance. Its acceleration is greater.
T.What did you infer after performing activity No.2 and why?
S.Momentum and energy both are conserved in this activity.
T.What did you infer performing activity No.3 and why?
S.Acceleration is reciprocal to mass?
T.What did you infer after reforming activity No.4 and why?
S.Frictional force depends on nature, mass and shape of the body and also force applied on it.

Student – 4

T.What in your opinion is caused by force?
S.Force changes position of the body.
T.Do you think motion necessarily means presence of force?
S.Yes.
T.Explain it.
S.No response.
T.How force is related with motion?
S.F motion?
T.How many types of force and motion do you encounter in your daily life?
S.Motion: circular, linear; force: frictional force, gravitational force.
T.Constant force results in constant velocity or average velocity or uniform velocity or any other?
S.Causes accelerated motion?
T.Distinguish between linear motion and curvilinear motion and cite three examples of each type of motion?
S.In linear motion, body moves in straight-line, curvilinear – motion body moves along curved path.
T.What will be the nature of the graph (V vs T) if body has got constant acceleration?
S.Straight line graph.
T.How do you distinguish between normal acceleration and tangential acceleration?
S.Normal acceleration: due to the force perpendicular to the surface of the body, Tangential acceleration: due to the weight of body along the surface of the body?
T.During storm a fruit and leaf are separated at the same time from the tree. Do they reach the ground at the same time?
S.No they do not reach as size and mass of fruit is greater than leaf.
T.Moving bodies do work. Comment on it?
S.No work is done if motion is not there.

T.What did you infer from activity No. 1 and why?
S.The motion of body depends on mass, shape and size of body.
T.What did you infer after performing activity No.2 and why?
S.As we increase mass of the body time period of body increases.
T.What did you infer performing activity No.3 and why?
S.If we increase mass of the body for same force acceleration decreases.
T.What did you infer after reforming activity No.4 and why?
S.Overall conclusion motion of body depends on shape size and mass and frictional force plays a crucial role.

Student – 5

T.What in your opinion is caused by force?
S.Pull or push.
T.Do you think motion necessarily means presence of force?
S.Yes.
T.How force is related with motion?
S.If a body is at rest, it can only move when there is an application of force on it.
T.How many types of force and motion you encounter in your daily life?
S.Frictional force and circular motion, rolling motion….
T.Constant force results in constant velocity or average velocity or uniform velocity or any other?
S.Uniform velocity and average velocity?
T.Distinguish between linear motion and curvilinear motion and cite three examples of each type of motion?
S.Linear motion is motion along straight line. Example player walking on pitch ii a cricket ground. Curvilinear motion – No response.
T.What will be the nature of the graph (V vs T) if body has got constant acceleration?
S.Linear graph?
T.How do you distinguish between normal acceleration and tangential acceleration?
S.No response.
T.During storm a fruit and leaf are separated at the same time from the tree. Do they reach the ground at the same time?
S.Masses are different they will reach the ground at different time.
T.Moving bodies do work. Comment on it?
S.No response.
T.What did you infer from activity no. 1 and why?
S.This activity deals with all Newton's laws of motion.
T.What did you infer after performing activity No.2 and why?
S.Conservation of energy.
T.What did you infer performing activity No.3 and why?
S.Newton's laws of motion & frictional force.
T.What did you infer after reforming activity No.4 and why?
S.Frictional force depends on shape and size of body.
S stands for student's response and T stands for teacher's question.

Table-2: Students' extracts of written answers related with activity No.1

Student	Response
S-1	Heavy body takes least time to complete the motion.
S-2	The heavier body takes more time than the lighter body. As the mass increases velocity of the body decreases thus it takes more time to reach the end point.
S-3	The heaviest ball takes much time in order to reach the end point.
S-4	Linear momentum depends on mass and velocity.
S-5	Student concludes that more mass less acceleration.

Table-3: Students' extracts of written answers related with activity No.2

Student	Response
S-1	Energy is conserved in this activity.
S-2	Heavier body oscillates or covers greater part in the curved portion.
S-3	Frictional force is directly proportional to mass of the body. Thus heavier body will oscillate for greater time.
S-4	This activity is based on conservation of energy
S-5	Student concluded that as we increase the weight of ball the time duration of oscillation increases.

Table-4: Students' extracts of written answers related with activity No.3

Student	Response
S-1	Tension depends upon mass applied.
S-2	As the mass increases the distance traveled by system decreases. Thus, it implies that frictional force is directly proportional to the mass of the body. Newton's II law and Newton's III law of motion are applicable in this activity.
S-3	III law of motion (action and reaction) is applicable.
S-4	Mass increases the acceleration of the body decreases
S-5	I and III laws of motion are applicable in this activity.

Table-5: Students' extracts of written answers related with activity No.4

Student	Response
S-1	Spherical body takes least time to reach the ground in comparison with others.
S-2	Rolling friction not only depends on the weight and surface of contact with the slide but also on its shape and size.
S-3	The body whose surface area of contact between two bodies is less takes less time to reach ground because frictional force is less i.e. Spherical body takes least time to reach the ground comparatively to others.
S-4	Sliding friction more than rolling friction.
S-5	Body is moving down on the inclined plane. Normal force is balanced by the component of weight which is mg Cosθ. The other component Mg Sinθ causes the motion of body and the frictional force F_s opposes the motion of the body. The frictional force is independent of the surface area of the body. It only depends on nature of the surface and the way by which body moves. For different given bodies the following observations are made: Cubical body: It takes maximum time to reach on the plane surface Prism shaped body or tetrahedron: It take less time than cubical body. Cylindrical body: It reaches quickly on the plane surface. Spherical body: It reaches more quickly on the plane. Inference: Time taken to reach on the plane surface varies as $T_{tetrahedron} > T_{cube} > T_{cylinder} > T_{sphere}$.

ANALYSIS OF THE RESPONSES

Response to each question of MBT was analyzed and discussed in order to understand the reasons of options favoured by the students. Alternative frameworks were identified on the basis of responses given by the students. For this reason, attention was paid primarily to the wrong options (responses) rather than to the right responses. The following conclusions can be broadly drawn:

Overall percentage of un-responded, correctly responded and wrongly responded options is 12.7, 30 and 57.3 respectively.

The examination of students' responses given the clear impression that a significant fraction of students at all levels (+2, UG, G and PG) carry alternative frames.

STUDENTS' FRAMEWORFS

In order to identify students' alternative frame works we have conducted interviews audio and video graphically and asked students to write reasons for opting the correct option in a particular question. Analysis of responses obtained through MBT tests, interviews (StudentS1-5), reasonings and written answers (Tables-2-5) indicates the following students' frame works:

Students recognize the branch of physics which deals with motion and forces producing motion as
kinematics
mechanics
dynamics.
Students recognize mechanics as
the study of motion deals with force $F = mdv/dt$.
study of velocity and acceleration
Students recognize kinematics as
the branch of mechanics in which we deal with all types of motion.
the study of motion of body and related phenomenon with force.
Students recognize linear motion as unidirectional motion in straight line.
Students recognize curvilinear motion as motion on inclined surface or curved path.
Normal acceleration is
perpendicular to the object.
rate of change of velocity.
applied at a point where force is maximum.
Due to tangential acceleration
object moves on the inclined plane.
body moves on circular path.
centripetal force acts on a body.
Students recognize force as pull or push.
Force causes displacement, change in position, velocity and acceleration.
Force is always greater than the inertia of the body (pulley)?
Constant force results in
constant velocity
uniform velocity
accelerated motion
Presence of force is necessary for motion
Even if a body is at rest there exists force.
No force no motion
No work no motion
Moving body causes displacement thus work is done.
The motion of the body depends on its nature of material and weight.
Rate of change of velocity = change of acceleration.
Acceleration is always in the direction of velocity.
Grater mass have grater momentum.
Impulse is greater of larger mass.
Centripetal force acts inward from radius but directs outward.
Constant speed results in zero acceleration.
Force and velocity always has in the same direction.
Gravitation force increases velocity.
Motion is due to frictional force. It always works opposite to the motion.
Frictionless surface has no change in velocity.
Frictional force depends on shape, size, mass and area of contact.
Rolling friction is lesser than kinetic friction.
Rolling friction depends on the weight, surface of contact, shape and size.
Sliding friction is always more than rolling friction.
Time taken by heavy body to get stopped is more.
Heavier body (ball) takes lesser time as compared to lighter body to cover same distance as acceleration of heavier body is larger.
Heavy body has more potential energy and hence during its motion travels larger distance in comparison to lighter body.

IMPLICATION OF THE STUDY

Responses were obtained using a questionnaire having multiple-choice questions, questions to be answered giving reasoning and asking the students to perform activities during which they were interviewed. The written responses as well as audio and video recorded versions after transcription were analyzed. These responses indicate that there is a significant difference and a wide gap between the learning outcomes as expected from the curriculum given to the students and their real learning at all levels. It is also noted that there are no significant differences amongst students at different levels. There can be a number of reasons such as transactional strategies are not effective, concepts are not internalized because of students' sticky nature to naïve theories, students do not find content being interesting enough and correlating concepts with practical experiences, students are not able to apply their knowledge to find solution to unfamiliar situations and teachers' behaviour induced incorrect generalization. To bridge the gap between what we teach and what is learnt and to remove alternative frame works of students related with concepts of mechanics, following steps may be adopted during teaching learning of mechanics:

· Students should be made familiar regarding common scientific processes viz. observation, identification, classification, discovering relationships, performing measurements, experimentation, establishing cause effect relationships, interpretation of results, inference, prediction and making hypothesis and testing the same. Special attention may be paid on processes of science during teaching and aiming to make students keen observers with an

eye for details, recognition of similarities and differences, inquisitive, developing understanding of concepts of mechanics and process and find applications of the same. Focused emphasis on experiments, problem solving and projects related with concepts of mechanics may be given by the teachers so that students can get an opportunity to have a first hand experience of the process involved. Teaching learning of concepts of mechanics should be done in such a way that the learners must realize and appreciate the interface of mechanics with other disciplines.

· The teachers must teach in such a way that constructivist learning situation has to be created during curriculum transaction (NCF-2005). Classroom experiences should be linked with experiences out side the classroom situations. They should move beyond the position of having a general awareness that students are having difficulties with parts of the concepts of mechanics to being able to interpret the students' thinking more analytically so that the teachers are in better position to plan and to implement the next stage of teaching.

· Teachers must identify alternative frames related to the concepts of mechanics in the initial stage and provide a curriculum that takes into account the existing alternative frames. Accordingly their thought structures must be studied and modified. Teachers should plan their lessons, activities, questions etc focusing on the understanding and application of the basic concepts of mechanics. A feedback from the students at the end of the lecture will be taken and then self-analysis of the lecture should be done. Other fellow teachers should also critically analyze the feedback. Finally remedial measures should then be taken by the teachers to rectify the alternative frames of the students.

· Teaching-learning process of concepts of mechanics should be linked with the life outside the school and beyond textbooks. It should also relate to the various scientific, environmental, technological, social and ethical values. Day to day experiences must also be incorporated into the classroom activities giving real feeling of oneness between society and learning. Integration of new conception with already existing conception must be included in the teaching. Conceptual bridging between the old and new conceptions through a variety of examples and experiences must be done during teaching learning process.

· Active engagement of students in construction of knowledge through relevant activities related with the concepts of mechanics has to be facilitated. Active engagement involves enquiry, exploration, questioning, debates, application and reflection, leading to theory building and the creation of ideas/positions. Teacher must provide opportunities to question, enquire, debate, reflect, and arrive at concepts or create new ideas.

· Intelligent guessing has to be encouraged as a valid pedagogic tool. Quite often, students have an idea arising from their everyday experiences or because of their exposure to the media, but they are not quite ready to articulate it in ways that a teacher might appreciate. It is in this 'zone' between what they know and what they almost know that new knowledge often takes the form of skills, which are cultivated outside the school, at home or in the community. All such forms of knowledge and skills must be respected by the teachers.

CONCLUSION

The investigation of students' responses obtained through a questionnaire, practical activities and individual interview given the clear impression that a significant fraction of students carry alternative frames about the concepts of mechanics. It is also indicated from the responses that there is a wide gap between the learning outcomes as expected from the curriculum given to the students and their real learning at all levels (+2, UG, G and PG).

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