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Study Of Applying The Innovative Teaching Technique 'Kinesthetic Learning Activity' To The Senior Secondary Students With Physics Major And To Analyse Statistically The Effect Of KLA On The Topic 'Emission And Lasers: Ruby And HE-NE'.

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ABSTRACT:

Education develops an effective future citizen. Human beings learn through 4 different styles; named thus: auditory learner, visual learner, reading/writing learner and kinesthetic learner. The focus of this study is on the fourth category of learners, the Kinesthetic Learners. Based on the NEP 2020 innovative pedagogy clusters, various innovative teaching techniques have been identified. Of the many innovative teaching learning strategies devised, the Kinesthetic learning activity has been researched in this paper to teach 'Emission and Lasing action" in Physics to senior secondary students and to further analyse statistically the effect of KLA. The Paired t test conducted pre and post KLA gave a mean score of 7.552 and 19.018 respectively with the standard deviation being 2.9315 and 0.7975 respectively, the r value is 0.517, $p< 0.01$.The calculated value of t was 65.301 with p value 0.000 by using p value at 5% level of significance. Such a value of t indicates a highly significant statistical difference between the pre and post KLA scores. The score shows that students have comprehended the topic extremely well. KLAs method of teaching the topic "Emission and Laser" and other such topics in Physics, is a valuable tool for "content related" exercises having high ambiguity, which many students struggle with.

Keywords : Kinesthetic learning activity, Physics, Emission & Laser, paired t test

INTRODUCTION:

Types of Learner

Education spans through every world group for development of an effective future citizen of the modern world, but across these groups, individuals have their own unique styles of learning and utilising that knowledge for innovations and social ventures. Human beings are attuned to learning through 4 different styles according to their genetic makeup and personality (Malvick, 2000).

- The auditory learner (Filiz and Fethi, 2017) - humans who are attracted to sounds, music, voice intonations, auditory aids such as sound and voice recordings work very well with them;
- The visual learner (Philominraj, et. al., 2017) - humans who find it very comfortable to learn with the help of sight, they need to see an object, phenomenon or scenario with their eyes to understand its best pictures, films, reels which are utilized for such students.5
- The reading/writing learner (Miller, B., 2012) - this is the learner towards which maximum educational environments are geared; they can easily learn from books, they are copious note takers too, and score very high in paper pencil testing.
- The Kinesthetic Learners (Castolo and Rebusquillo, 2007-2008) - One learns best by experience, by being involved physically in classroom experiences. This is the learner who has largely been labelled as disruptive and naughty, mostly unable to settle and focus in traditional classrooms.

The present study focuses on methods and plans to engage Kinesthetic learner students much more in the classroom, and utilise their energy towards better comprehension of concepts, and make them better problem solvers.

Recognizing kinesthetic learners in a classroom (Bagel, A., 2004): Kinesthetic learners, also termed as tactile learners, learn through experiencing or doing things. These learners use their hands to utilise their sense of touch and enjoy involvement and acting out of events. These types of learners are always fidgety and often excel at sports or dance. They take frequent breaks while studying.
Catering to kinesthetic learners: Setting up movement is the best way teachers can help these students learn. The students are facilitated to act out a certain scene or a certain scientific concept from the subjects taught. Incorporating movement into lessons: learning games that involve moving around in the classroom, pacing around the corridor to help them memorise, or bringing up children to the whiteboard to write would cater to the requirement of Kinesthetic learners. Abstract ideas and difficult concepts become easier for Kinesthetic learners to understand once they can physically sense the topics studied. This further accelerates positive learning.

Education under the perspective of the National Education Policy:

The National Education Policy 2020 is embarking on upgrading the education tools used by the educators in the 21st century. For the same the roadmap of pedagogy is distributed in the following innovative pedagogy clusters.

1) Blended learning: Rethinking the purpose of the classroom and classroom time,

2) Flipped classroom: Use of technology and classroom interaction,

3) Multi literacies and discussion based teaching: Fostering questioning by critical thinking.

4) Embodied learning: Capitalizing on emotions and creativity .

5) Experiential learning: Enquiry in complex world,

6) Computational thinking: Problem solving approach through logic.

Among different innovative practices which the Ministry of Education is emphasizing, the important approaches are; collaborative approach, reflective approach, constructivist approach, metacognitive approach, E-teacher education approach, value-based approach, blended learning approach, soft skill approach et. (MHRD,2021)

Benjamin Bloom in 1956, an educational psychologist at the University of Chicago with his team proposed "The taxonomy of Educational objectives" in the year 1956 which laid the foundation of educational research. Further research in time, in India introduced the "National Education Policy" in 2020 and the National Curriculum Framework prescribes the goals and framework of Education to be implemented which needs intervention in terms of innovation in teaching methodology. Further going deep; into teaching Physics in the School curriculum to the students in Senior secondary school in the Science stream, with Physics major has always been a challenge for the School educators as there is very little scope of experiments in this level. The abstractness of the Physics topics further adds to the challenges of reaching out to the students. A lot of researchers in Physics probed further for different pedagogical tools to improve teaching in Physics in the School curriculum in the senior secondary level for the Science stream students with Physics major. Hence innovative teaching tools need to be researched and identified to make understanding Physics easy.
Based on the NEP 2020 innovative pedagogy clusters, various innovative teaching techniques have been identified like Kinesthetic learning activity such as Kinesthesia, Tactile learning activity, Chladni sand patterns on drumsticks, Vector approach, collaborative learning enhanced by computer tools, podcast delivered instructions etc.

Education under Indian perspective:

There are differences in socio economic strata in India, and so, the schools have differences due to different standards of living between the urban and rural areas (Dhanalakshmi and Palya, 2012). As per Unified District Information System for Education
(U-DISE, 2016-17), total numbers of schools in India were 15.3 lakhs out of which nearly 12.97 lakh schools were in rural areas. Total enrolment in schools was 25.13 crore out of which 18.02 crore was enrolment of students from rural areas. Though rural schools can offer, a more intimate learning environment and a stronger sense of community, it is also important to address the challenges that rural schools face in terms of resources and infrastructure, in order to ensure that all students have access to quality education. Intellect does not differentiate in the rural and urban students rather the learning tools, surrounding environment, availability of time and help, skills and access to different facilities like electricity and technology does. Every problem cannot be immediately resolved, but it can be ensured that students are taught in a manner that is easily comprehensible in their given capacity. Considering these factors, the curriculum for rural school students must be curated using the NEP guidelines.
It hardly matters where a school is located, what matters is whether the teachers have ignited that spark in that child to become the best version of themselves and the child is intrinsically motivated to do something in life for which conceptualizing and loving the subject becomes very important. It has also been noticed due to the availability of free space and agile upbringing; the children from rural area are more kinaesthetically involved than otherwise. Keeping in tandem with this thought process; Kinesthetic learning activity can be used very effectively on rural children, and also on urban children as they enjoy this activity even more as a novelty (Richard, A. J., 2020). Of the many innovative teaching learning strategies devised, the Kinesthetic learning activity has been researched in this paper as it does not require any complex technology and can be performed in any type of school environment in urban or rural locations, with or without gadgets or electricity
Research says students learn better when on the move! "Students are fast learners, better retainers, can build excellent neural networks thus can manipulate information more effectively when they are in active physical motion." says Erwin. Many authors argue that students' conceptions of basic physical phenomena are rooted in basic schemas, originating in fundamental kinesthetic experiences of being. (Erwin, et. al., 2021). This paper mainly researches one such innovation, the kinesthetic learning activity. Kinesthetic Learning Activity (KLA) (Sivilotti and Pike, 2007) is defined as "any activity which physically engages students in the learning process".
KLAs is sometimes referred to in literature as simulation role play (Aubusson, et. al., 1997) or analogical modelling role play (Sivilotti and Pike, 2007).

Objective:

Considering more number of rural schools in India which is dense in Kinesthetic learners and considering the need of NEP 2020 in India, with Physics as a subject of concern the objective of this paper is to identify an innovative teaching methodology 'Kinesthetic Learning Activity' and apply this innovative teaching technique in 'Emission and Lasing action" and to further analyze statistically the effect of KLA on this Physics topic.

METHODOLOGY:

Case Study to apply the innovative teaching technique Kinesthetic learning activity in 'Emission and Lasers: Ruby and He-Ne' and to analyze statistically the effect of KLA on the Physics topic.

Population and Sample

In Physics the topic of Emission and Lasers is one such abstract topic which has been taken as the subject of research to teach the class 12 students of Techno India Group Public School, Ariadaha in North 24-pargana, Techno India Group Academia, Survey Park in South 24-paragana and Techno India Public School, Konnagar, Hooghly by the Kinesthetic learning method. The topic "Emission, Laser: Ruby and He-Ne" was taught to a sample of 221 students in two different classes XI and XII.

Data:

Two sets of data was collected from the 221 respondents pre KLA and post KLA based on the 20 questions spread over the 6 levels of bloom's taxonomy on the topic "Emission, Laser: Ruby and He-Ne".

Research process of KLA for Emission and Lasers: Ruby and He-Ne

The sample of 221 students from XI & XII were taught the topic of "Emission, Laser: Ruby & He-Ne" in the above school in a traditional way. Next, a multiple-choice questionnaire with 20 questions for 'Emission, Laser: Ruby and He-Ne' covering all six major cognitive skills based on Bloom's taxonomy: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation was prepared.

Then this pre KLA test was administered on the sample of students and the data was collected through a Google form.

After that different kinesthetic learning activities were framed and KLA was conducted in the school staircase on the same sample of students who further answered the questions.

The data post KLA was collected on the same 20 questions.

Lastly, the data was analysed by using paired t tests to study the effectiveness of the KLA, as to how this innovative way of introducing Physics topics to Senior secondary students helped them understand Physics better.

Prior knowledge:

Since this is a very abstract topic, a prior knowledge on energy levels was expected from the children. Hence, recapitulation was done based on these pointers.

1) According to Bohr's model every atom has N number of energy levels, with fixed energy values which can be denoted as Bohr orbit.

2) Transition between 2 energy levels releases or absorbs one quanta of energy, thus following the Quantization principle.

3) Transition cannot take place between forbidden gaps.

4) Transition can take place by emitting or absorbing more than one photon.

5) Lifetime of the metastable (second excited state) is more than the lifetime of the first excited state.

Assumptions

For simplicity of the experiment the energy difference between different levels is considered the same ($E=h\nu$).

Rules of the game (Kinesthetic learning activities)

1) The school staircases are marked as energy levels.

The first staircase is marked E_o: the ground energy level, next staircase is marked E_1: the first excited state or the second energy level, followed by E_2 the second excited state or the third energy level and so on as we go higher up the stairs.

2) Four placards indicating packets of energy, with energy $E=h\nu$ are kept ready.

3) If a student takes one packet of energy, that is one placard with energy $E=h\nu$, he can go a step up, implying gaining energy results in transition to the higher energy level.

4) If a student loses one such packet, a student goes a step down, implying losing energy results in transition to the lower energy level.

4) Similarly, if a student accepts three packets of energy, the student moves three steps up and on losing three such packets one moves three steps down.

Kinesthetic Activities

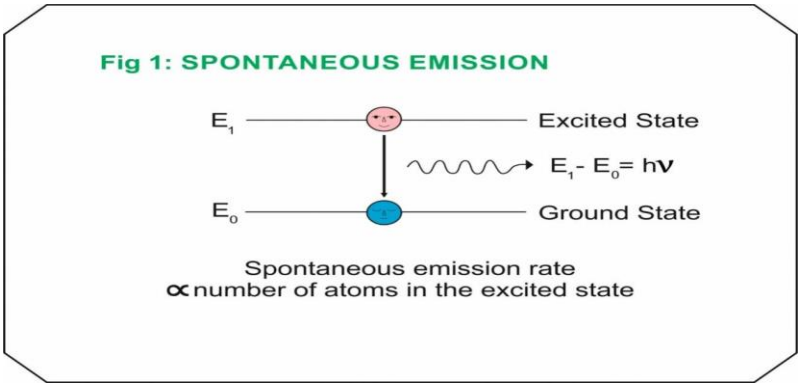


Fig.1: Stimulated absorption

A student in step one marked E_o, indicating ground level is given a placard with energy E=hν. This implies he gains energy and moves a step up to the excited energy level one, E_1. This indicates absorption has been stimulated and is known as Stimulated absorption (fig.1).

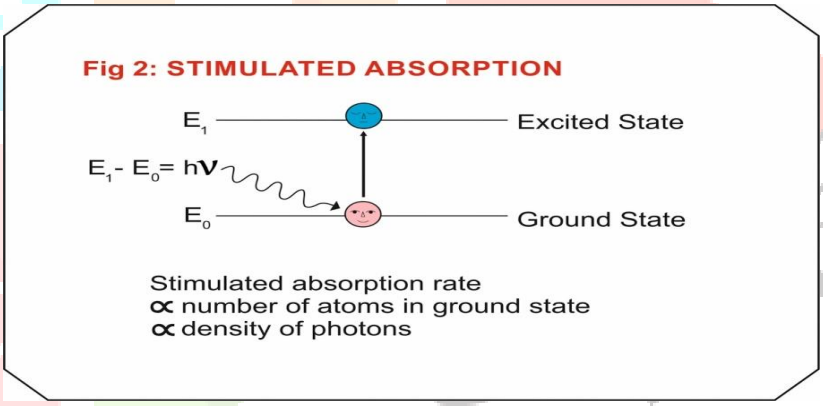


Fig.2: Stimulated absorption

A student in step one marked E_o, indicating ground level is given a placard with energy E=hν. This implies he gains energy and moves a step up to the excited energy level one, E_1. This indicates absorption has been stimulated and is known as Stimulated absorption (fig.2).

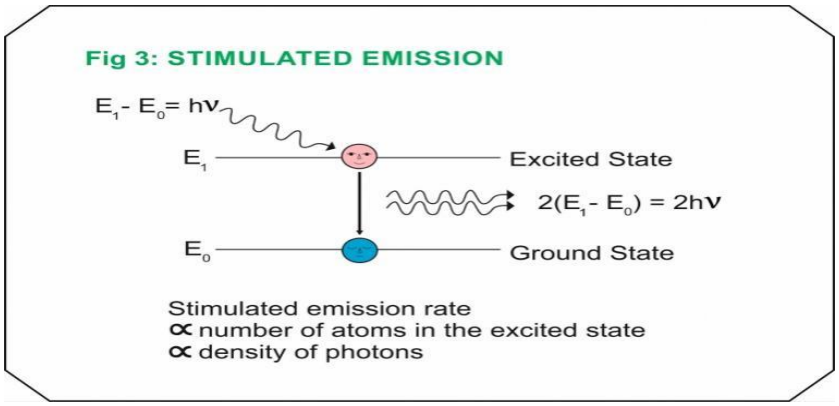
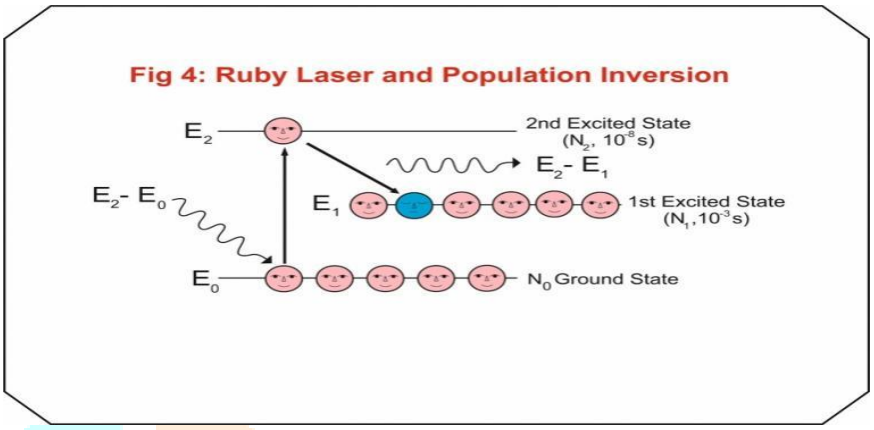


Fig. 3: Stimulated emission

The student from KLA 2 is already in the first excited state E_1, already holding a placard with energy E=hν with him. Another placard with energy E=hν is further handed over to him and the level above the first excited state is blocked, ensuring he has no way to move up, hence he moves down. He moves to the ground energy level and throws out both the placards, thus resulting in stimulated emission with energy E=2hν. This is known as stimulated emission (fig.3). The 2hν introduced the concept of Quantization of Energy to students



where E = nhν where n can take any integer value. Here n=2.

Fig. 4: Ruby Laser and Population inversion

5 students, indicating 5 electrons are in the ground energy level E_o. One student is given 2 placards with energy E=hν each. Using the knowledge of KLA2, he moves to the second excited state, E_2. But the lifespan of the second excited state is less (10^{-8}s), hence he cannot stay there and falls back to the first excited state having a greater lifespan (10^{-3}s), This results in population inversion (fig.4).

During this process the student throws one energy placard with energy E=hν, indicating emission of energy ($E=E_2-E_1=h\nu$). This is the process of Ruby lasers (fig.4).

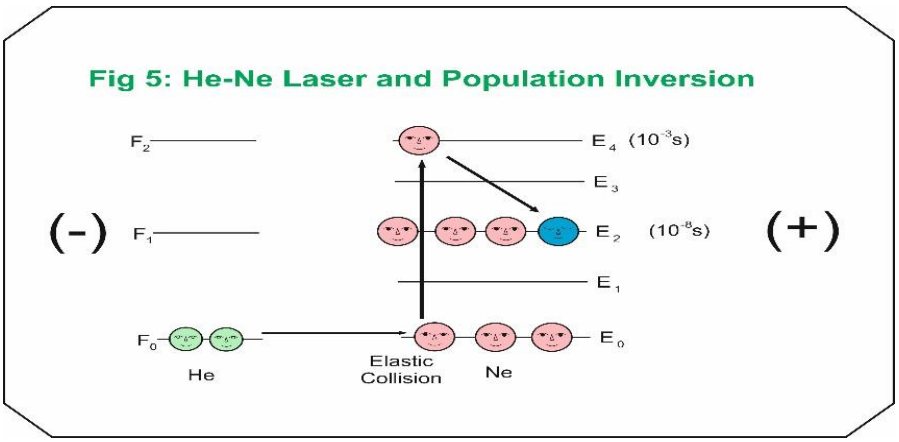


Fig. 5: He-Ne Laser and Population inversion

The stairs are marked with a line in the middle. The left side indicates Helium atoms energy level, where every alternate step is an energy level F_o, F_1, F_2. The right side indicates Neon where every step is an energy level E_o, E_1, E_2. The Class 11(thin) students were identified as Helium atoms and Class 12 (healthy) students as Neon atoms. The Class 11 (thin) students have less volume and less mass like Helium atoms, whereas Class 12 (healthy) students have greater volume like Neon.

So, when photons strike the He, Class 11 (thin) students, they accelerate to a greater extent owing to the lesser mass. They further strike the Class 12 (healthy) students, Ne atom. Due to elastic collision between them, the entire energy is transferred to the Ne atom, which moves to the higher unstable 2nd excited state. Since the lifespan of the second excited state is less (10^{-8}s), he cannot stay there and falls back to the first excited state having a greater lifespan (10^{-3}s), the metastable state this results in population inversion (fig.5). During this process of coming down to the metastable state the student throws one energy placard with energy E=hν, indicating emission of energy ($E=E_2-E_1=h\nu$). This is the lasing action of Helium Neon lasers (fig.5).

Statistical tools:

For testing the difference between pre and post KLA, Paired t test which was introduced by W. S. Gosset in 1908 (Amanda Ross and Victor, 2017) is used under the Null Hypothesis, H_o: pre = post. i.e., there is no difference between the mean of pre KLA and mean of post KLA.

The appropriate formula of t is given by

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

where, $\bar{d}$ = mean of the differences between pre (say, x) and post (say, y) score.

$$= \frac{1}{n}\sum_{i=1}^{n} di$$

n = number of observations, s = standard deviation of the difference

$$= \sqrt{\frac{\sum_{i=1}^{n}(d_i-\bar{d})^2}{n-1}}$$

$$= \sqrt{\frac{\sum_{i=1}^{n} d_i^2-n(\bar{d})^2}{n-1}}$$

Standard Error (SE) = $\frac{s}{\sqrt{n}}$

Confidence Interval (CI) for the mean difference is calculated to know what limits the true value is likely to lie. The formula at 95% CI is given by

$\bar{d} \pm t_{5\%}$ SE($\bar{d}$) for (n-1) df

where, df is the degree of freedom

Correlation between pre (x) and post (y) is given by

$$r = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2 \sum_{i=1}^{n}(y_i-\bar{y})^2}}$$

Results and Discussion: 'Emission and Lasers: Ruby and He-Ne'

Table 1: Paired sample statistics between Pre KLA and Post KLA marks obtained by the students in Emission and Lasers: Ruby and He-Ne

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Post	19.018	221	.7975	.0536
Pre	7.552	221	2.9315	.1972

Table 2: Paired samples Correlation statistics between Pre KLA and Post KLA marks obtained by the students in Emission and Lasers: Ruby and He-Ne

	N	Correlation	Sig.
Pair 1 Post and Pre	221	0.517	0.000

Table 3: Paired Samples Correlations statistics between Pre KLA and Post KLA marks obtained by the students in Emission and Lasers: Ruby and He-Ne

				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 Post - Pre	11.4661	2.6103	.1756	11.1200	11.8121	65.301	220	.000

The data analysis using the Paired t test conducted have the findings shown in the table. The Paired t test conducted uses the null hypothesis (H_o): there is no difference between pre kinesthetic and post kinesthetic learning activity on applying this kinaesthetic teaching technique in Physics, on the topic Emission and Lasing actions. After conducting the exercise, It is found that the pre and post mean score of the sample is 7.552 and 19.018 respectively with the standard deviation being 2.9315 and 0.7975 respectively. By applying correlation between the pre and post KLA score the r value is 0.517, $p < 0.01$.

For further analysis between the pre and post KLA score, paired t test is applied. The calculated value of t was 65.301 with p value 0.000 by using p value at 5% level of significance. Such a value of t indicates a highly significant statistical difference between the pre and post KLA scores. Not only did the students enjoy the activity immensely, their scores show that they have comprehended the topic extremely well. We have been able to reject the null hypothesis with a high level of confidence. Thus, KLAs method of teaching the topic Emission and Lasing actions and other such topics in Physics, is a valuable tool for "content related" exercises having high ambiguity, which many students struggle with.

CONCLUSIONS:

The topic Emission and Laser when introduced by KLA gave the pre and post KLA score, on applying paired t test as stated. The calculated value of t was 65.301 with p value 0.000 by using p value at 5% level of significance. Such a value of t indicates a highly significant statistical difference between the pre and post KLA scores. Not only did the students enjoy the activity immensely, their scores show that they have comprehended the topic extremely well. We have been able to reject the null hypothesis with a high level of confidence. Thus, KLAs method of teaching the topic Emission and Lasing actions and other such topics in Physics, is a valuable tool for "content related" exercises having high ambiguity, which many students struggle with.

By incorporating experiential learning activities into the lesson plans, students found it easier to recognize concepts being taught and remained focused longer by switching class activities from regular instruction to experiential learning. And finally, these activities induce great deal of excitement and enthusiasm into the classroom and the topics dealt are etched in the memory with clarity and depth..

An important aspect of education in the present world is emotional intelligence, increasing the levels of happiness and satisfaction in a child, the sense of well-being is a vital portion of facilitating future citizens of any civilization. For that we need students who are disciplined in mind, body and habits. Kinaesthetic activities make them engaged in movement instead of sitting still in one place, making them healthier. Also, because they abide by certain rules of movement within the classroom, they understand how to keep things orderly and not let it become chaotic. This is what true discipline is all about, which is order through movement, not through fear or coercion. Students are their own masters, they learn well, they design their learning, and are appreciated, imbibing a sense of joie de vivre in their education and daily life.

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