I J C R M

International Journal of Contemporary Research In Multidisciplinary

Research Article

Modelling Steam-Based Innovative Ideas of Secondary School Students

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Abstract

A qualitative study was organized with the rationale to model high school-level students' innovative ideas in problem-solving models. For this reason, the sample (n=20) of the study was selected from secondary school students studying in the 5th to 9th standards. Purposive sampling with a quota technique was used to select the sample. For the perfect sampling, an interest inventory (*Interest Inventory on Science, Technology, Engineering, Art, and Mathematics (II-STEAM)*) of 10 questions on a five-point Likert scale was developed by the researcher. Content reliability was done with the help of two experts. The training was provided to the students, and at the end of the training day, students were asked to rate the training with an Opinionnaire. The results of the study showed that the training was effective. The students in groups developed two innovative STEAM-based working models based on the received knowledge in the training. Two innovative models are the productivity and effectiveness of the training. So, the study showed that the training given to the interested students was very fruitful. Formed groups worked with their concepts on and out of paper. And higher appreciation to the group leader by INSPIRE AWARDS is that the working model ULTRA SPECS AND SHOES FOR BLIND was selected for the presentation at the NATIONAL level, and SMART DUSTBIN at the DISTRICT level. Thus, the study has proved that not only was the organization of idea competition helpful, but also that given training was fruitful in transforming ideas into working models.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 16-11-2024
- **Accepted:** 23-12-2024
- **Published:** 30-12-2024
- **IJCRM:**3(6); 2024: 213-220

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Manuscript

Kachave DS. Modeling steam-based innovative ideas of secondary school students. Int J Contemp Res Multidiscip. 2024;3(6):213-220.

KEYWORDS: Innovative model, intrinsic motivation, modelling, training, working groups

1. INTRODUCTION

"Always listen to children… they might have ideas we've never thought of." - Alexander G. Bell.

Creativity among children is almost inborn; every child is creative, and degrees may vary, but not the basic manifestation (Piaget, 1950; Bruner, 2004). Child is a part of society, and society is expecting form teachers to promote originality, creativity, and innovative spirit amongst this generation to inculcate skills such as design mindset, computational thinking, adaptive learning, physical computing, etc. (NITI AAYOG, 2019). NITI AAYOG's operation manual on ATAL TINKERING LAB says that Children are natural tinkerers and have a unique approach to problems. We want our next generation to be more sensitive to the problems faced by not just them and their families or neighbours, but also other socially disadvantaged sections of society. So, the schools should give enjoyable work to the students, and it can be done through projects. Projects are given to students to create a pool of talent that is future-ready, by providing opportunities for working outside the classroom, to get them to think out of the box, using

hands-on experimentation and collaboration with the latest technology.

Need of the Study

The 21st century has become the knowledge era, and knowledge is giving the foundation to the sustainable development of society. So, it has become the duty of schools to give the opportunities to the next generation learners to do something; projects like do-it-yourself (DIY). Teachers should encourage and motivate students to become solution providers and get engaged in self-learning that will not only lead to the development of higher-order thinking skills, but may eventually lead to discoveries, innovations, and inventions.

So, it was expected to find the next generation of learners, who are interested in learning about STEAM, and facilitate them in the ATAL Tinkering Lab's environment. As a facilitator, we provided opportunities for learning to the interested students.

2. OBJECTIVES

The objectives of the study were as follows:

1. To provide the STEAM-based training to interested students in ATAL Tinkering Lab.
2. To evaluate the effectiveness of STEAM-based training provided to interested students in ATAL Tinkering Lab.
3. To collect the innovative ideas from selected secondary school students.
4. To develop the working models on STEAM-based innovative ideas.

3. METHODOLOGY

A mixed-method approach was used for conducting this study. The researcher used the Survey method for selecting the sample and the Experimental method for conducting the remaining research. A mixed-method approach was used as shown in the following Figure 1.

Mixed-method approach

Population and sample of the study

The study population consisted of secondary school students attending Annasaheb Kalyani Vidyalaya in Satara. The sample for the study was selected with the help of the quota sampling technique. Purposefully, we circulated the *Interest Inventory on Science, Technology, Engineering, Art, and Mathematics (II-STEAM)* to 50 students from 5th to 9th standard students (10 from each standard) to find interest in STEAM. And from these students, only 20 (n=20) students were selected for the training with the help of II-STEAM. To interpret the raw data, an analysis was done using percentages.

Fig. 1: Mixed-method approach

Tools used for the study

1) Interest Inventory on Science, Technology, Engineering, Art, and Mathematics (II-STEAM)

The concept strongly affects an individual's affective functioning with respect to learning (Bandura, 1997; Hidi, 1990; Kim, 2005). For this research, we used an interest inventory developed by the researchers on a five-point Likert scale.

II-STEAM was sent to two Ph. D.-degree-awarded assistant professors of the College of Education for the content validity. Before the remark of two assistant professors, there were 15 statements in the interest inventory, and as per their remark, only 10 statements were kept in the final inventory. Five factors were kept in mind to form the inventory: 1) Science, 2) Technology, 3) Engineering, 4) Art 5) Mathematics. The interest inventory instrument was named as *Interest Inventory on Science, Technology, Engineering, Art, and Mathematics (II-STEAM).*

Factors considered for inventory

Table 1: Factors considered for inventory

Sr. no.	Statements related to	Total statements
1	Science	2
2	Technology	2
3	Engineering	2
4	Art	2
5	Mathematics	2
Total statements		10

Procedure of the research

The research has gone through different stages, and the stages are shown in the following Figure 2.

The stages of research

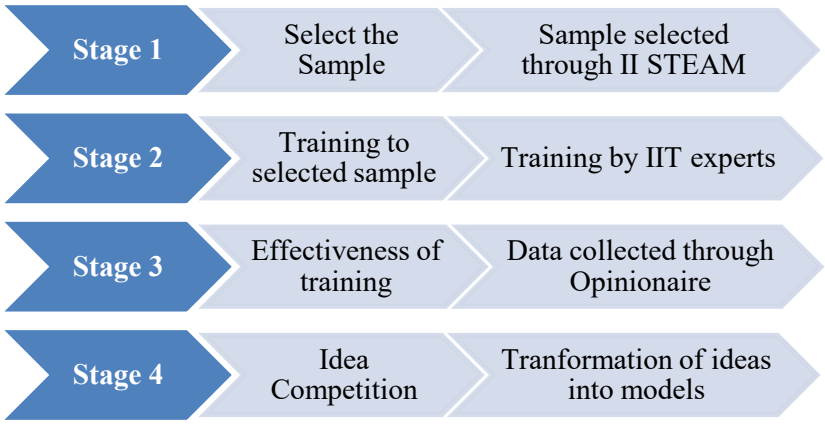


Fig 2: The stages of research

A) STAGE-1

On a particular day, we took 50 printouts of the Interest Inventory on Science, Technology, Engineering, Art, and Mathematics (II-STEAM). Quota sampling technique was used by us for selecting the sample for the study. Later on, we circulated an interest inventory to 50 students from 5th to 9th standard (10 from each standard). After collecting filled II-STEAM from students, the received data was tabulated in an Excel sheet, and a scheme of marking was used as per the following Table No.02.

Marking scheme for responses of interest inventory

Table 2: marking scheme for responses of interest inventory

Sr. No.	Response type	Marking scheme for responses
1	Always	5
2	Often	4
3	Sometimes	3
4	Rarely	2
5	Never	1

As per the marking scheme (Table 2) first 20 highest students were selected for further research and training (Table 3).

The range of marks of students

Table 3: Range of marks of students

Sr. No.	Range of marks	Number of students	% of students
1	41 to 50	12	24
2	31 to 40	14	28
3	21 to 30	13	26
4	11 to 20	8	16
5	0 to 10	3	6
All students		*50*	*100%*

B) STAGE-2

After selecting the sample, as per the objective we organized a training session of five hours daily for a week, for the students in ATAL Tinkering Lab with the help of Experts from IIT, Powai (Mumbai). These hands-on training sessions covered the basic concepts of STEAM education. In these training sessions, the students were introduced to Ideation, Design thinking, Computational thinking, and Physical computing with the following content-based module shown in Table No.04.

Content-based training is provided to students.

Table 4: Content-based training provided to students

Day	Training module related to
1	Informative Session on Innovations ,Invention,s and STEAM
2	Introductory session on electronic equipment/devices, Sensors, etc.
3	Practical-based session on Arduino
4	Orientation session on coding
5	Practical Session on –3D Printing
6	Illustrative session on Ideation, Design Thinking, Computational Thinking, and Physical Computing.

C) STAGE-3

On the last day of training, an opinionnaire with 5 points; a developed Likert scale, was given to students to evaluate the effectiveness of the provided training. This questionnaire consisted of 6 statements related to the training module, and 4 were general perceptions about training. The responses were collected as 1) Poor, 2) Fair, 3) Good, 4) Very good, 5) Excellent. There were 10 statements in the Opinionnaire, and for the responses following marking scheme was used given in Table No. 05.

Marking scheme for responses of opinionnaire

Table 5: Marking scheme for responses of opinionnaire

Sr. No.	Response type	Marking scheme of responses
1	Excellent	5
2	Very good	4
3	Good	3
4	Fair	2
5	Poor	1

The marking scheme for responses was used as Poor=1, Fair=2, Good=3, Very good=4, and Excellent=5. After the collection of all the questionnaires, the data were tabulated in MS Excel, and an analysis was done.

D) STAGE 4

Transformation of ideas into two working models.

After the training, we conducted an idea competition to collect need-based innovative ideas for solving local issues and problems. Out of 16 listed ideas from the idea competition, the best 5 ideas were preferred by the participants. Later on, participants finalized Two ideas for developing working models were as follows: i) ULTRA SPECS AND SHOES FOR BLIND, ii) SMART DUSTBIN.

4. RESULTS

The training was provided to interested students in a week with introducing STEAM-based basic concepts. At the end of the training, the responses about the training were collected with the help of an Opinionnaire. The responses collected through the Opinionnaire were analysed and presented in the following Table 06.

Points covered to evaluate the training through an opinionnaire

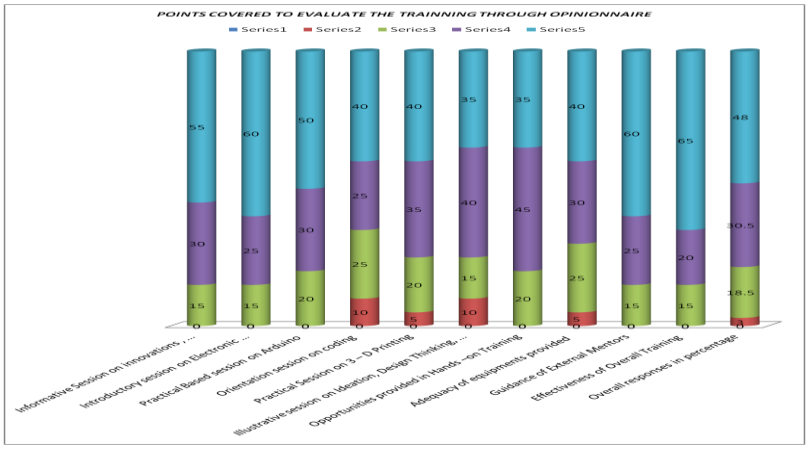
Table 6: Points covered to evaluate the training through the questionnaire

Sr. No.	Statement	Number of responses & % of responses				
	Marking scheme of responses	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
1	Informative Session on Innovations, Inventions, and STEAM	0 (0%)	0 (0%)	3 (15%)	6 (30%)	11 (55%)
2	Introductory session on electronic equipment/devices, Sensors, etc.	0 (0%)	0 (0%)	3 (15%)	5 (25%)	12 (60%)
3	Practical-based session on Arduino	0 (0%)	0 (0%)	4 (20%)	6 (30%)	10 (50%)
4	Orientation session on coding	0 (0%)	2 (10%)	5 (25%)	5 (25%)	8 (40%)
5	Practical Session on –3D Printing	0 (0%)	1 (5%)	4 (20%)	7 (35%)	8 (40%)
6	Illustrative session on Ideation, Design Thinking, Computational Thinking, and Physical Computing.	0 (0%)	2 (10%)	3 (15%)	8 (40%)	7 (35%)
7	Opportunities provided in Hands–on Training	0 (0%)	0 (0%)	4 (20%)	9 (45%)	7 (35%)
8	Adequacy of equipment provided	0 (0%)	1 (5%)	5 (25%)	6 (30%)	8 (40%)

9	Guidance of External Mentors	0(0%)	0 (0%)	3 (15%)	5 (25%)	12 (60%)
10	Effectiveness of Overall Training	0 (0%)	0 (0%)	3 (15%)	4 (20%)	13 (65%)
	Overall responses & % of responses	**0 (0%)**	**6 (3%)**	**37 (18.5%)**	**61 (30.5%)**	**96 (48%)**

Overall responses of students about the training sessions are shown in the above table. The above table shows that 48% students say that the training was excellent, 61% say that the training was very good, 18.5% say that the training was good, 3% say that the training was fair, and no one says that the training was poor. The profile of points covered in Opinionnaire to evaluate the training is shown in the following Graph No.01.

Points covered in the questionnaire to evaluate the training.



Graph 1: Points covered in the questionnaire to evaluate the training

Series-1: Poor, **Series-2:** Fair, **Series-3:** Good, **Series-4:** Very good, **Series-5:** Excellent

In the training session, the students were told to observe their surroundings and identify the problems, and list them. Students listed 16 ideas at the end of the training day. In these 16 ideas, we gave the chance of choice to all students to note the best five ideas to work on in the upcoming days. There was no time-bounding criterion to form the innovative models from given ideas. There was our limit of resources, so we all resolved to work only on two models. As per the nominations received from students, we selected to work on two innovative models. In the next few days (nearly in one month), both groups worked in the ATAL Tinkering Lab in their leisure time to develop innovative models. The following table no. 07 shows the nominations for innovative ideas.

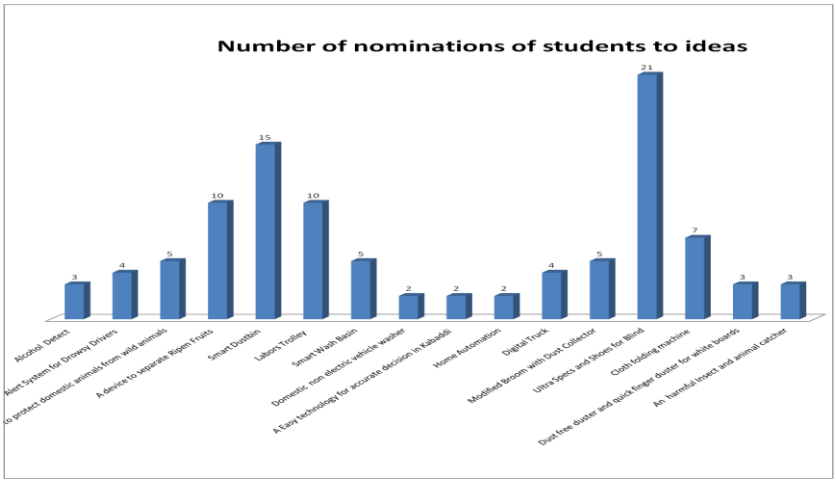
Nominations for innovative ideas by participant students

Table 7: Nominations for innovative ideas by participant students

Sr. No.	Innovative IDEAS of students	Number of nominations of students for ideas
1	Alcohol Detect	3
2	Alert System for Drowsy Drivers	4
3	Alert System for farmers to protect domestic animals from wild animals	5
4	A device to separate ripe fruits	10
5	Smart Dustbin	15*
6	Labors Trolley	10
7	Smart Wash Basin	5
8	Domestic non-electric vehicle washer	2
9	An easy technology for accurate decision-making in Kabaddi	2
10	Home Automation	2
11	Digital Truck	4
12	Modified Broom with Dust Collector	5
13	Ultra Specs and Shoes for the Blind	21*
14	Cloth folding machine	7
15	Dust-free duster and quick finger duster for whiteboards	3
16	A harmful Insect and animal catcher	3
Total number of choices (Nominations)		**100**

*The two best ideas selected to work on developing the models

Profile of nominations received for innovative models



Graph 2: Profile of nominations received for innovative models

Two working innovative models, 1) ultra specs and shoes for the blind, 2) smart dustbin, were developed by both the A and B groups of the students. The development of two working innovative models is the major productivity of the study.


1


2


3


4

Images
1. Ultra specs and shoes for the blind,
2. Our permanent blind student, Miss. Piyusha Bhosale is using 'ultra specs and shoes' as the model.
3. Smart Dustbin
4. Smart Dustbin

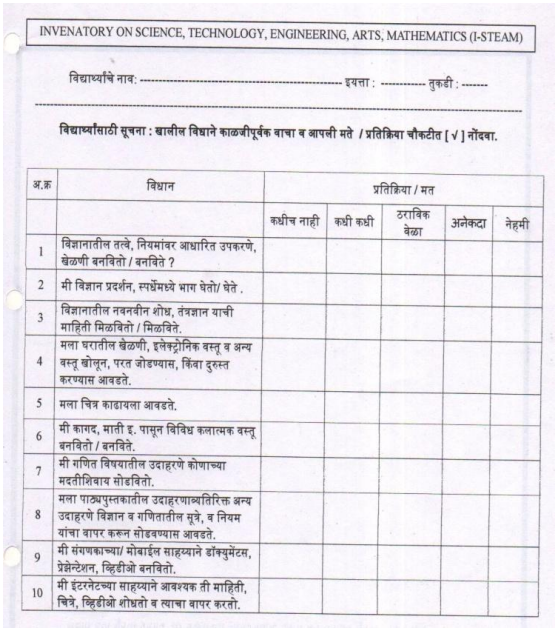
REFERENCES

1. Bandura, A. Self-efficacy: The exercise of control. San Francisco: W.H. Freeman and Company; 1997.
2. Bruner J. A short history of psychological theories of learning. Daedalus. 2004;133(1):13-20.
3. Hidi S. Interest and its contribution as a mental resource for learning. Rev Educ Res. 1990;60(4):549-71.
4. Kim H. Learning implicit user interest hierarchy for web personalization [dissertation]. Melbourne (FL): Florida Institute of Technology; 2005.
5. Piaget J. The psychology of intelligence. New York: Routledge; 1950.
6. Opinionnaire [Internet]. Wiktionary; 2021 [. Available from: https://en.wiktionary.org/wiki/opinionnaire
7. Constructivism (philosophy of education) [Internet]. Wikipedia; 2021. Available from: https://en.wikipedia.org/wiki/Constructivism_(philosophy_of_education)
8. NITI Aayog. Annual report 2019 [Internet]. New Delhi: NITI Aayog; 2019. Available from: https://niti.gov.in/sites/default/files/2019-11/AnnualReport2019.pdf
9. NITI Aayog. ATL operation manual handbook [Internet]. New Delhi: NITI Aayog; 2021. Available from: https://niti.gov.in/writereaddata/files/ATL%20Operation%20Manual%20handbook.pdf

APPENDICES

Appendix- A

Marathi version of the Interest Inventory on Science, Technology, Engineering, Art and Mathematics (II-STEAM)



INVENATORY ON SCIENCE, TECHNOLOGY, ENGINEERING, ARTS, MATHEMATICS (I-STEAM)

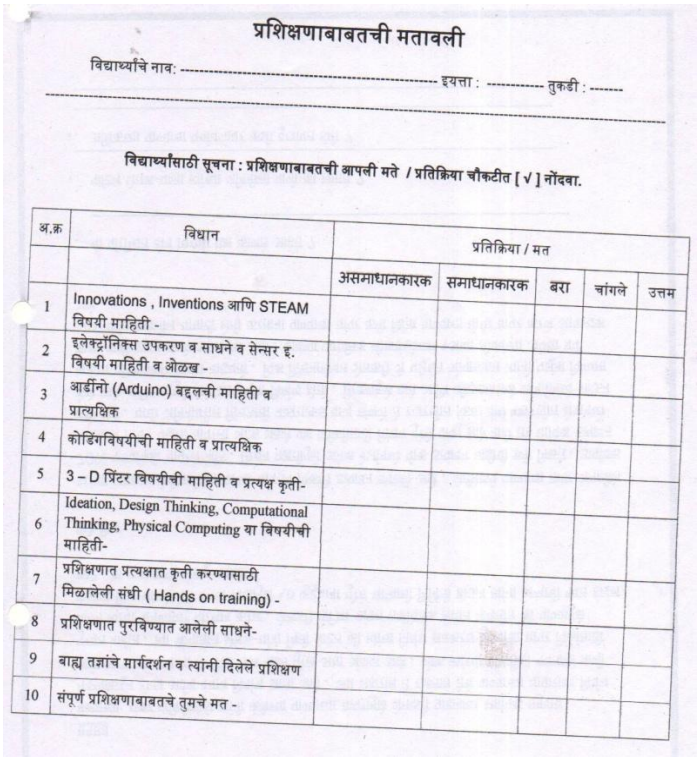
विद्यार्थ्याचे नाव: ---------- इयत्ता : ---------- तुकडी : ------

विद्यार्थ्यांसाठी सूचना : खालील विधाने काळजीपूर्वक वाचा व आपली मते / प्रतिक्रिया चौकटीत [√] नोंदवा.

अ.क्र	विधान	प्रतिक्रिया / मत				
		कधीच नाही	कधी कधी	ठराविक वेळा	अनेकदा	नेहमी
1	विज्ञानातील तत्वे, नियमांवर आधारित उपकरणे, खेळणी बनवितो / बनविते ?					
2	मी विज्ञान प्रदर्शन, स्पर्धेमध्ये भाग घेतो/ घेते .					
3	विज्ञानातील नवनवीन शोध, तंत्रज्ञान याची माहिती मिळवितो / मिळविते.					
4	मला घरातील खेळणी, इलेक्ट्रोनिक वस्तू व अन्य वस्तू खोलून, परत जोडण्यास, किंवा दुरुस्त करण्यास आवडते.					
5	मला चित्र काढायला आवडते.					
6	मी कागद, माती इ. पासून विविध कलात्मक वस्तू बनवितो / बनविते.					
7	मी गणित विषयातील उदाहरणे कोणाच्या मदतीशिवाय सोडवितो.					
8	मला पाठ्यपुस्तकातील उदाहरणाव्यतिरिक्त अन्य उदाहरणे विज्ञान व गणितातील सूत्रे, व नियम यांचा वापर करून सोडवण्यास आवडते.					
9	मी संगणकाच्या/ मोबाईल साहय्याने डॉक्युमेंटस, प्रेझेन्टेशन, व्हिडीओ बनवितो.					
10	मी इंटरनेटच्या साहाय्याने आवश्यक ती माहिती, चित्रे, व्हिडीओ शोधतो व त्याचा वापर करतो.					

Appendix- B

Marathi version of Opinionnaire



प्रशिक्षणाबाबतची मतावली

विद्यार्थ्याचे नाव: ---------- इयत्ता : ---------- तुकडी : ------

विद्यार्थ्यांसाठी सूचना : प्रशिक्षणाबाबतची आपली मते / प्रतिक्रिया चौकटीत [√] नोंदवा.

अ.क्र	विधान	प्रतिक्रिया / मत				
		असमाधानकारक	समाधानकारक	बरा	चांगले	उत्तम
1	Innovations , Inventions आणि STEAM विषयी माहिती -					
2	इलेक्ट्रॉनिक्स उपकरण व साधने व सेन्सर इ. विषयी माहिती व ओळख -					
3	आर्डीनो (Arduino) बद्दलची माहिती व प्रात्यक्षिक					
4	कोडिंगविषयीची माहिती व प्रात्यक्षिक					
5	3 – D प्रिंटर विषयीची माहिती व प्रत्यक्ष कृती-					
6	Ideation, Design Thinking, Computational Thinking, Physical Computing या विषयीची माहिती-					
7	प्रशिक्षणात प्रत्यक्षात कृती करण्यासाठी मिळालेली संधी (Hands on training) -					
8	प्रशिक्षणात पुरविण्यात आलेली साधने-					
9	बाह्य तज्ञांचे मार्गदर्शन व त्यांनी दिलेले प्रशिक्षण					
10	संपूर्ण प्रशिक्षणाबाबतचे तुमचे मत -					

Appendix- B_01
Group- A: Students' list

Sr. No.	Name of the Student	STD
1	Miss. Ira Vikrant Mandape	VI
2	Miss. Riya Sitaram Ravool	VI
3	Mst. Pranav Rajendra Kale	VII
4	Mst. Parth Rohit Barge	VII
5	Miss. Tanaya Krushanat Patil	VII
6	Miss. Ishwari Hemant Ithape	VIII
7	Mst. Atharv Navnath Jagdale	VIII
8	Mst. Shubham Milind Khade	VIII
9	Mst. Suyog Sanjay Gosavi	IX
10	Mst. NIranjan Sandip Pawar	IX

Appendix- B_02
Group- B: Students' list

Sr. No.	Name of the Student	STD
1	Mst. Piyush Nilesh Gadhave	VI
2	Mst. Shriram Amol Bodhe	VI
3	Miss. Sifa Chand Shaikh	VII
4	Mst. Sarthak Ramchandra Jadhav	VII
5	Mst. Shreyas Subhash Buwa	VII
6	Miss. Anjali Maruti Mohite	VIII
7	Mst. Adityaraj Bramhdev Waghmode	VIII
8	Miss. Sayali Sanjay Nikam	IX
9	Mst. Omkar Ajitkumar Phadtare	IX
10	Miss. Vaishnavi Vikas Karape	IX

Appendix-C_01
Some photos from training sessions