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Poster Presentation: A novel online assessment tool for motivation, relevance and foundation for research in Mathematics

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Abstract **—** Creation of academic & research posters gives the students an opportunity to develop indispensable skills like inquisitiveness, critical thinking, analytical thinking and dissemination of findings in creative way. This paper describes the formative use of poster presentation in a course of applied mathematics in the first year of the undergraduate engineering program in the western part of India. The authors have designed the internal assessment through poster presentation (IATPP) based on the ARCS model of motivation that also encourages students to find relevance of mathematics with other fields, seeds the foundation of research in their foundation years of engineering and develops a habit of self-learning and peer learning. The authors then discuss their experience of executing this novel approach of using poster presentation to bridge the gap between mathematics and core engineering courses through IATPP. Students' perceptions and results have proved IATPP an interesting, engaging, encouraging, motivating and challenging online assessment strategy that exposes them to mathematical concepts, helps them relate mathematics with other fields and empowers them with several vital life-long learning skills.

Keywords **—** ARCS model of motivation; Engineering education; Foundation of research; Mathematics education; online assessment; Poster presentation.

JEET Category **— Practice**

I. INTRODUCTION

THE COVID-19 pandemic originated from China has left an enormous effect on the health of people across the world. Humankind around the world has faced a tremendous change in almost all aspects of life including education. Just like universities around the world, universities across India also had to shut down their physical campuses from March 2020, and had to shift all academic, curricular & co-curricular programs online (Bao, 2020). This was an unexpected change. Educational institutes around the world were not prepared for this sudden transition from classroom-based education to the virtual mode of education. Professors and students faced a wide range of logistic, technical, financial, and social problems (Lassoued et al., 2020). Especially for the mathematics teaching fraternity, their world had turned upside down. Before the pandemic, online math education was not very popular. Especially in India, with a lack of resources, teaching mathematics in the online mode was a task to perform

When the institutes have started functioning completely in the virtual mode, along with online education, online assessment became a big concern for all educationists. Assessment for learning has been studied for a long time by many researchers (Balan, 2012; Black & McMillan, 2012; McMillan, 2013; Stacey & Wiliam, 2012; Wiliam, 2008). In some parts of India, for several grades, assessments are skipped due to hurdles of online assessments. According to Tarkar, 2020, the assessment of the students related to the learning should not be skipped as it played an important role in the placements of students and their employability. In the online mode, traditional assessment methods could not function as per their desired way. There were various errors related to the measurement of learning reported in online assessment tools in comparison to the usual measurement. At such time, there was a high need of introducing some assessment method that preserve all aspects of assessments as well as motivate students and expose them to the field of research.

Motivation is one of the most important prerequisites in learning (Slavin, 1991). When students engage themselves in tasks in which they are self-motivated, they tend to exhibit many pedagogically desirable behaviour. These include spending more time on the task, persistence in the face of failure, more elaborative processing and monitoring of comprehension, selecting more difficult tasks, greater creativity and risk - taking, selection of deeper and more efficient performance and learning strategies, and the choice of activity in the absence of an extrinsic reward (Lepper, 1988; Middleton & Spanias 1999; Yavuz et al., 2012). Motivation is an internal factor of students which need an external stimulus that is the environment. In this case, the teacher could play a direct role to increase students' learning motivation, especially in the interest that develops attention, relevance, confidence, and satisfaction (Jamil et al. 2019). It is important to motivate the learners and ensure the continuity of motivation during assessments. Authors have tried to preserve all features of learning while assessing. The assessment method discussed here addresses all aspects of the ARCS model of motivation developed by John Keller (Keller, 1987). The ARCS model has four aspects: Attention, Relevance, Confidence and Satisfaction. Through the newly designed assessment tool for engineering mathematics, authors tried to bring students attention towards applications of mathematics, find relevance with other fields by bridging the gap, develop confidence in

students to create posters and get the satisfaction of achieving the outcomes.

The challenges faced motivating engineering students while teaching and assessing mathematics are enormous. Desai (2020) have tried to develop tools to motivate students in engineering Mathematics by introducing WEM- AN AV tool which for answering "Why Engineering Mathematics?". Many courses offered in higher engineering required a lot of fundamental knowledge of mathematics. Hence engineering departments are always in high demand of relating mathematics with their core engineering courses. They expect bridging the gap should be filled right from the initial years of their undergraduate education. They expect students to know, understand and apply advanced techniques of mathematics in the first and the second year of engineering and get ready to utilize them as and when required in their core engineering courses in higher studies. Often mathematics teachers are caught between the demands of engineering departments and the needs of groups of students who lack confidence, have significant gaps in their mathematical knowledge and sometimes lack abilities in mathematics (Croft & Ward, 2001). Such learners are unable to bridge the gap between mathematics, engineering and real life. Also according to Billington, H. L. (1997), a diversity of assessment strategies is needed in order to assess students fairly. By only using one form of assessment, we may be discriminating against some students. Now a days, industry-ready students are the demand of time. To fulfill this demand, math teachers should come out of the traditional method of assessing that measures only student's problem-solving skills. The authors tried to break the limitations of these traditional assessment methods adopted in the western part of India.

In this paper, the authors have introduced an online assessment method that motivates students, encourages them to relate math with other fields and also seed a foundation for research. This paper describes an innovative approach of the poster presentation to these challenges that involve a mixture of traditional and modern assessments. Creating and presenting posters requires students to develop and use the vital skills of enquiry, critical analysis, and dissemination of findings. (Bracher, 1998; Rowe, 2017). This paper describes the formative use of poster presentation for the first - year undergraduate engineering students of one of the very reputed engineering colleges situated in urban parts of Mumbai, India. The authors then present their experiences of utilizing the poster presentation as a formative assessment in online mode. At the early developmental stage of their professional studies, poster presentation can be as successful as an assessment strategy in online mode. It can be an innovative and engaging experience for students.

II. OBJECTIVES

Educational assessment is the systematic process of documenting and using empirical data on the knowledge, skills, attitudes and beliefs of students. Assessment helps in the improvement of the learning. Learning is a continuous process and it should be preserved while assessing students. Every assessment method must have some well-defined objectives which can be measured using some performance indicators. The authors have designed the formative assessment called IA through Poster Presentation (IATPP) keeping the following main objectives in mind.

- To motivate students to focus on the beauty of mathematics rather than only performance in assessments
- To seed a foundation of research in students foundation years of under graduate engineering programme
- To find the relevance of topics learnt in mathematics with engineering and real - life
- To inculcate the habit of exploring, peer learning and self-learning
- To embolden students to explore mathematics beyond the classroom
- To involve learners at higher cognitive levels of Bloom's taxonomy (i.e. application, analysis and creation.)
- To encourage students to develop lifelong learning skills like curiosity, presentation, punctuality etc.

In addition to the main objectives listed above, the authors also intended to develop the following skills in students through this learning experience.

- To retain learner's interest in the mathematical courses
- To enhance the creativity and confidence level of students
- To introduce a variety of assessment methods to cater to different learning styles of students

III. METHODOLOGY

To bring in the feature of continuous assessment in the curriculum, the assessment of students at K.J. Somaiya College of Engineering (KJSCE) has been divided into several assessment heads. Students have to successfully complete these in-semester assessments before appearing for the final exam at the end of the semester. Students have to appear for one In Semester Exam (ISE) and at least two Internal Assessments (IA). Faculty, teaching the particular course, has the freedom to choose any assessment tool and method to conduct IA for their course. This IA component contributes 20% to the overall grading of that course of the students. For the Applied Mathematics course, authors have used poster presentation as a tool for the IA component. Henceforth this assessment will be referred as IATPP (IA through Poster Presentation). The authors have planned and executed the activity in a structured and systematic way. All the steps are

elaborated on below.

A. Targeted students

Out of the four semesters of applied mathematics courses, this activity was designed for first-year undergraduate students of Computer Engineering, Information Technology and Mechanical Engineering. Most of these students belonged to the urban parts of western India. Being first - year students; they were very new to engineering and least aware of the utility of mathematics in core engineering disciplines. The pre-survey revealed that 58.5% of students had never used poster presentation as an assessment tool in the mathematics course in their school education. 93.3% had agreed that before joining the engineering programme at KJSCE, most of the assessment methods used for mathematical courses were focused on problem-solving skills. On an average students had rated themselves at 3.5 on the level of motivation to explore the applications of mathematics in various fields, where 1 was least motivated and 5 represented most motivated. Students had undergone the traditional assessment methods in mathematics courses in their formative years. The initial years of higher education was found to be the correct phase to introduce these students to different perspectives of learning mathematics. Also, IATPP intended to inculcate several other desirable skills in the students as mentioned in the objectives of the activity.

B. Process of identifying topics for IATPP

To come out of the conventional methods of assessment which were problem - solving, quizzes or open - book tests, authors experimented with the poster presentation as an assessment tool. The conventional method mapped up to maximum level 3 (apply) of Bloom's taxonomy (Krathwohl, 2002), the method presented in this paper (IATPP) corresponded to the higher levels of bloom's taxonomy (analyze & create) and also encouraged students to perceive the concepts of mathematics in a broader context.

Mathematics lecturers in engineering colleges have to find the golden mean between the demands of the engineering department which expect students to apply the knowledge of mathematics in technical courses in higher semesters and the needs of a group of students having varying abilities in mathematics. Simple Algebraic calculations are easily connected to daily life. However, due to traditional math teaching, it is often difficult for students to connect advanced mathematical concepts like calculus, linear algebra, vectors, etc. with their day to day lives. When students do not see why they have to learn a topic, this impacts their motivation and retention.

To overcome these hurdles and to preserve the concepts of learning while assessing, math teachers were required to list down some topics which may be assigned to students for IATPP. Keeping the main objectives of this assessment in mind, applications of topics listed in the math curriculum were listed. These applications cover a variety of applications related to different fields of sciences, engineering, technology, social sciences and life sciences.

Due to rich experience in teaching Applied Mathematics courses in technical institutes, regular collaborations with core engineering course teachers, a number of interactions with higher grade students, alumni and other stakeholders and regular references from research papers, mathematics teachers could list down some probable topics for IATPP. After focused discussion amongst all the math faculty at KJSCE and referring to the higher semester's curriculum, 25 different topics were finalized to be assigned to students for IATPP. The shortlisted topics were related to the mathematical concepts taught in first - year engineering. These topics were interesting, had applications in higher education and related math with real life.

A few of the topics assigned to the students were Applications of differential equations in fields like Population growth, Carbon dating, Economics, Biology, Circuit theory, Physical Motion, SEIR Epidemic models, Applications of complex numbers in Signal analysis, Electromagnetism, Applications of matrices in Image Processing, Computer graphics, etc.

C. The topic assignment process

Every branch of engineering at KJSCE has two divisions and in every division, students are divided into 3 batches of 25 students. From the list of 25 topics, each student of a batch is assigned a different topic through random allotment. Hence, there were 3 students, from different batches in a class, who had the same topic to work upon. Though the students were allowed to discuss among themselves all possible data related to the topic, each one of them was expected to come up with some different information in their posters. This helped in imbibing the peer learning ability in students and also gave them an opportunity to use their personal creativity to present the information.

In the online mode of teaching - learning – evaluation, use of a Learning Management System (LMS), was an essential requirement. The author's institute had its own LMS to help faculty members and students in the regular teaching - learning – evaluation process. All the instructions, the list of topics, assignment of topics, grading criteria and related rubrics were posted in the LMS.

The Faculty also conducted a discussion session with students to inform about available resources for the literature survey, clarify their doubts and guide them about the successful completion of the activity.

D. Submissions and Assessment of IATPP

After the assignment of topics, the students were given a time period of 20 days to explore the given topic. They were

encouraged to refer to as many online/offline resources as possible. These resources included different websites, books, journal papers, YouTube videos, etc. Students were encouraged to discuss with peers, interact with seniors and take guidance from their teachers. After going through the available literature survey, students were expected to analyze and evaluate available information, synthesize ideas and creatively demonstrate their understanding of the assigned topic in the form of a poster. Each one of them was expected to come up with some different information in their posters. This helped in imbibing the peer learning ability in students and it also gave them an opportunity to use their analytical skills to organize and present the information in the form of an A3 size poster with their choice of template and design. All students had come up with beautiful posters. Some of them are shown in Fig. 1

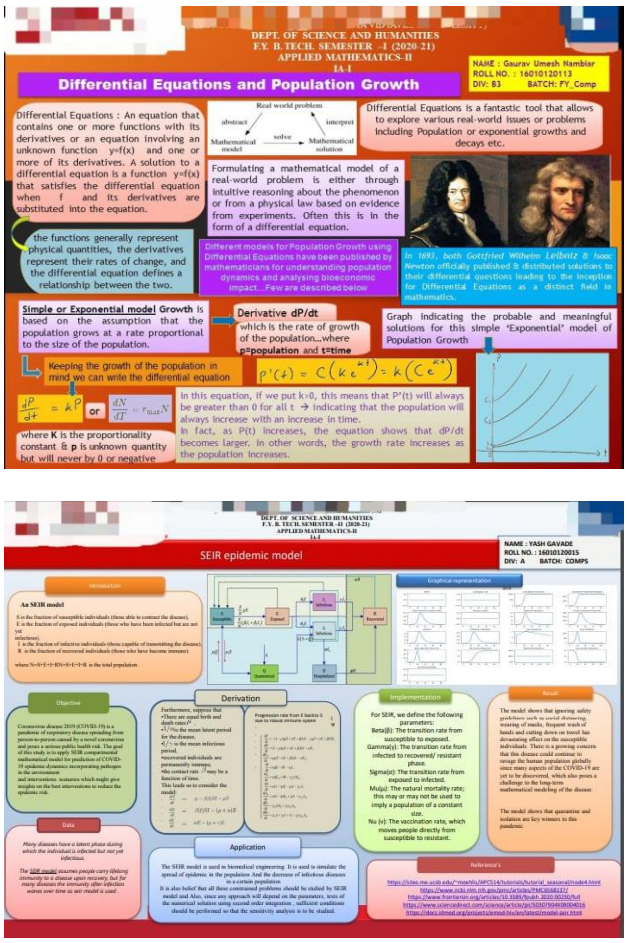

Fig 1: Students' posters for IATPP

Assessment of the posters was done with the help of a rubric that measured the students' submission on criteria like the relevance of the information provided with the assigned topic, utilization of content and space in the poster, creativity, plagiarism, punctuality and references given. Students were pre-informed about all the assessment criteria and they were encouraged to understand and follow the requirements of each criterion to perform well in their evaluation. This helped in making the assessment process consistent and transparent. The faculty members encouraged students to present the process of their poster making and key findings related to their topic during an online lecture. This was followed by a question answer session. This helped in transmission of ideas and made all students aware of other topics and the information related to them. The poster presentation helped students to connect their research skills with their communication skills.

IV. RESULTS/ FINDINGS

First - year B Tech students from Computer Engineering, Information Technology and Mechanical Engineering participated in IATPP. Pre-survey was conducted to identify the level of motivation, relevance and research exposure of students before the IATPP. In the pre-survey, on average students rated themselves at 3.5 on the level of motivation to explore the applications of mathematics in various fields, where 1 was least motivated and 5 represented most motivated.

Analysis of pre-survey revealed that 93.3% of students had agreed to the statement "Most of the assessment methods used for mathematical courses focused on problem-solving skills". These students had experienced only traditional evaluation activities like quizzes, problem - solving assignments or tests, etc. in their mathematical courses during their school education.

Before IATPP, only 9.6% of students were aware of most applications of mathematical concepts in real life and engineering, which were listed in IATPP topics. This showed that students were not exposed to the relevance of mathematical concepts to other fields. Also, 68.7% of students had not experienced any research - based assessment before joining the programme.

This pre-survey concluded that IATPP was novel for engineering students in the course of mathematics. Hence the analysis of the outcomes of IATPP was required to measure the level of achievements, especially the attainments of objectives. The findings of the success of IATPP were measured in two different ways.

1. On the completion of IATPP, a survey was conducted to gauge the effectiveness and success of the activity amongst students and future scopes.
2. Students' performance in IATPP.

The statistics of students who participated, evaluated and those who have responded by filling the survey questionnaire is shown in Table I.

TABLE I
CHARACTERISTIC AND STATISTICS OF STUDENTS

		No	Per (%)	PS	Response rate (%)
Dept.	Computer Engineering	170	42.71	166	97.64
	Information Technology	114	28.64	111	97.36
	Mechanical Engineering	114	28.64	109	95.61
Gender	Male	308	77.39	299	97.08
	Female	90	22.61	87	96.67

Abbreviations: No – Total no of students evaluated; Per – Percentage; PS – number of students participated in the survey

On completion of IATPP, a post - survey was conducted consisting of a questionnaire which focused on students' level of motivation, involvement and achievements of different objectives which were designed by authors before IATPP.

Post - Survey revealed that students spent considerable amount of time to complete the IATPP including the collection of material, curating and creating presentations. The Average time spent by students is 4.1 Hrs. 5.2% of students spent more than 8 hours completing IATPP (Fig 2). Students referred to books, research papers, websites, YouTube videos, interacted with peers and teachers. One student has reported interacting with his parents. (Fig 3)

46.9% of the students referred 2-4 references, 39.1% students have referred 4-6 references and 13.2% students referred more than 6 references for literature survey and creating posters. The statistics revealed that 68.7% of students who had never had any research - based activity earlier in their education life got the seed of foundation of research through IATPP.

The IATPP was intended to increase the student's level of motivation and was designed based on the ARCS model of motivation. The activity was successful in various aspects i.e. Attention, Relevance, Confidence and Satisfaction. 96% of students admitted the fact that the Poster activity was successful and brought their attention to applications of topics they are learning in mathematics. They admitted an increase in their interest in learning mathematical concepts after IATPP (Fig 4). 99% of students agreed that this activity boosted their confidence in presenting mathematical ideas concisely and creatively (Fig 5). Also, completion of this activity gave them a sense of accomplishment and satisfaction (Fig 6).

From the survey results, it can be concluded that IATPP increased their level of motivation from an average of 3.5 to 4.11on the scale of 1 to 5 (1 being the lowest). Students rated themselves more motivated and inclined towards finding applications of mathematical topics (Fig 7).

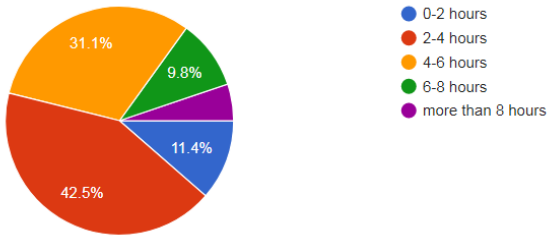

Fig 2: Time spent to complete IATPP

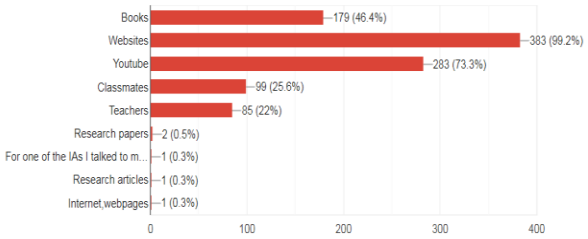

Fig 3: Sources of information

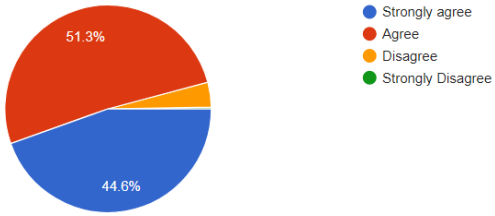

Fig 4: Increased level of Interest

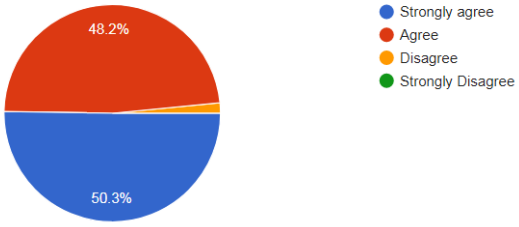

Fig 5: Boosted Confidence

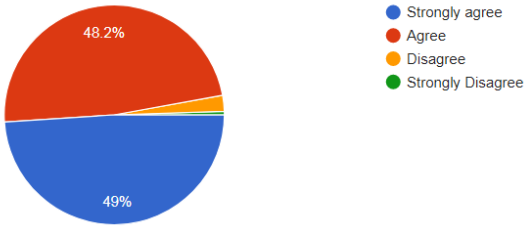

Fig 6: Sense of accomplishment and satisfaction

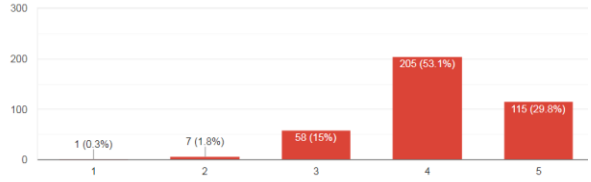

Fig 7: Level of motivation after IATPP

The students found IATPP more interesting, engaging than the conventional method of assessment in mathematics. They agreed that IATPP encouraged and challenged them to think beyond the boundaries of the prescribed syllabus. IATPP made them familiar with various possible applications of the concepts learnt in the Mathematics course and it enabled them to appreciate the importance of mathematical concepts in the engineering curriculum. Table II presents the statistics of the responses received from students on some of the important questions.

TABLE II
STATISTICS OF STUDENTS' RESPONSES

Criteria	SA	A	D	SD
Interesting & Engaging	54.7%	42.7%	2.1%	0.5%
Encouraging & Challenging	53.1	45.3%	1.3%	0%
Exposing to mathematical concepts	44.6%	51.3%	3.9%	0%
Help relate mathematics with other fields	50%	48.7%	1%	0%

Abbreviations: SA – Strongly Agree; A – Agree; D – Disagree; SD – Strongly Disagree

Students admitted that IATPP helped them inculcate many important lifelong learning skills such as analytical skills, presentation skills, research skills, time management, creativity, self-learning ability, inquisitiveness, peer learning etc. (Fig 8). In addition to the students' perception of the activity, their performance was analyzed in form of the marks obtained. The statistics shows that students have performed very well in terms of scoring marks (Fig 9).

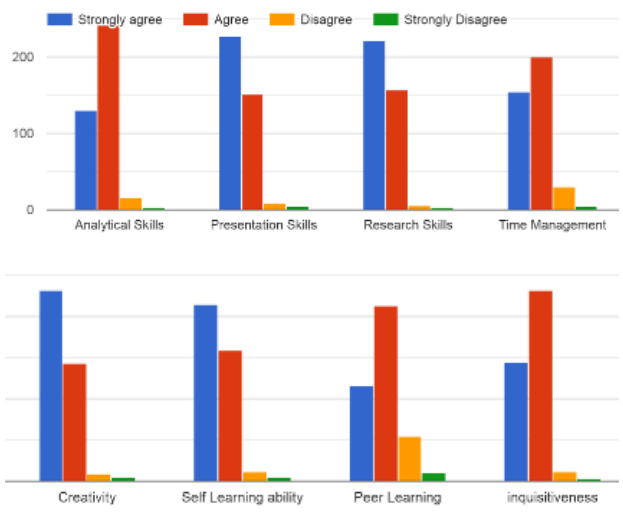

Fig 8: Acquired Lifelong learning skills

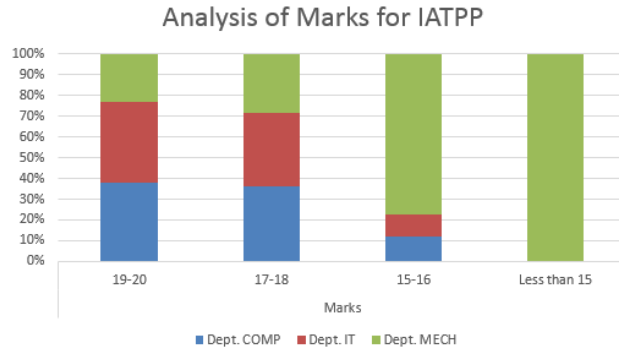

Fig 9: Analysis of students' performance in IATPP

In IATPP, out of 20 marks, 37.94% of students obtained more than 18 marks, 51.01% of students scored 17 or 18 marks and 7.54% of students secured 15 or 16 marks and only 3.52% of students scored less than 15 marks. The Department wise performance statistics are shown in Table III.

TABLE III
DEPARTMENT WISE ANALYSIS OF STUDENTS' PERFORMANCE IN IATPP

	Department		
Marks	COMP	IT	MECH
19-20	42.35%	43.85%	25.43%
17-18	54.71%	53.51%	42.98%
15-16	2.94%	2.63%	19.30%
Less than 15	0	0	12.28%

Abbreviations: COMP – Computer Engineering; IT – Information Technology; MECH – Mechanical Engineering

In all, IATPP was worth learning experience for students. In this assessment, they were not only exploring new domain but also quantifying their learnings. They found IATPP engaging, interesting, motivating, relating to curriculum, scoring and better than other traditional assessment methods (Fig 10).

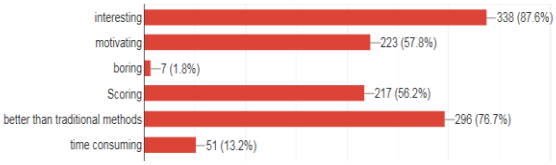

Fig 10: Learning experiences of IATPP

In their first year of higher education, when they are new to the system, these students were challenged by a pandemic. They were forced to start their journey of engineering education in the online mode. They were unable to meet and interact with their teachers and peers in person. IATPP allowed them to interact with their peers and enhance social skills even in the virtual mode. One student quoted in the survey about IATPP, "Activities are more fun than the normal methods. Due to group activities we also get to interact with our classmates which is not possible otherwise, we have barely talked to each other in person because of the pandemic." One more student said, "I personally enjoyed researching the less explored applications of a particular mathematical concept, and creatively presenting it. Poster making gave me a general and fair idea of the specific

concept. However, I am not sure if I learnt to solve the problem in detail, as the knowledge gained on the internet while researching was advanced. But ultimately, this was a great assessment method and I'm definitely looking forward to more of it!" The authors received many similar feedbacks from students that supported the satisfaction level and attainment of objectives listed by the authors before IATPP.

V. CONCLUSION & FUTURE SCOPE

Authors' well-defined objectives have turned a simple poster presentation technique into an effective online assessment tool for a mathematical course. By breaking most limitations of conventional methods of assessments, which are widely used for mathematical courses, IATPP has proved itself as a novel assessment tool. IATPP involve learners at higher cognitive levels of Bloom's taxonomy i.e. application, analysis and creation. IATPP manifested students to literature survey, triggered their inquisitiveness, critical & analytical thinking skills and creativity. It also helped them develop learning habits like beyond the classroom learning, exploring available resources, self-learning and peer learning. Students' perceptions and results have proved IATPP an interesting, engaging, encouraging, motivating and challenging online assessment strategy. Students got exposed to several mathematical concepts through this assessment technique. IATPP also helped them relate mathematics with other fields and empowered them with several vital life-long learning skills. 96.1% of students wanted to have similar types of assessment activities in their higher semester mathematics courses. Even though authors have executed IATPP in virtual mode, this technique can be easily adopted in the physical mode or blended mode of education. Through IATPP, the teacher's fraternity around the world can bring a variety in their assessments and give memorable learning experiences and motivation to students during assessments.

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