Learning by Vying in Automotive Fabrication in Engineering Education

[1]P V N Saichandu, [2]Dr. Kowdodi Siva Prasad
[1]Associate Professor Mechanical Engineering, Hyderabad Institute of Technology and Management
[2]Professor Mechanical Engineering, Hyderabad Institute of Technology and Management
[1] cponnekanti@gmail.com [2] kowdodi.siva@gmail.com

***Abstract*—By visualizing and engaging with the problem where many students struggle, mechanical engineering principles like Heat Transfer and FEM are better comprehended. Participating in design and development problems at the student level is one such approach that aids the students in picturizing, comprehending, and understanding the concepts. Students participate in a variety of racing competitions, such as the creation of the Quad Bike, Baja Buggy, Formula Student, etc. The students can create teams, build, and develop cars, compete against other teams nationally and globally, and more by taking part in these tournaments. Additionally, it improves the student's capacity for teamwork, empowers them to take on mission-driven projects, and develops their managerial and leadership abilities. Students improve their ability to comprehend, visualize a variety of engineering ideas during the process**

***Keywords*— Automotive Fabrication; Competition Based Learning; Test Bench; Quad Bike**

1. INTRODUCTION

Healthy competition is crucial to a student's life, academic performance, and career. Students are motivated by competition, which makes them work harder to achieve the greatest results. It helps the student focus more clearly and feel more accountable for a task or assignment, both of which will benefit his competitive professional career. When a student competes with their team, they gain valuable experience in working as a team, keeping harmony with the teammates, performing under pressure, and getting educated on the work of their fellow competitors.

The learner gains a great deal of knowledge, experience, and enjoyable learning from this process and action.

Student-focused competitions come in many forms, including Design Challenges, Hackathons, Design and Manufacturing Challenges, and student-level Motorsport Events. Because it incorporates engineering, high-performance, cutting-edge racing technologies, speed, and intense competitiveness, racing has recently become a popular topic among young engineers. Due to this, student-level motorsport competitions have become increasingly popular. These competitions allow student teams to design and build completely functional vehicles and compete against other teams both domestically and abroad. The SAE (Society of Automotive Engineers) International, SAE India, FMAE (Fraternity of Mechanical and Automotive Engineers) India, and ISNEE (Indian Society of New Era Engineers) India are well-known international organizations that host student- level motorsport competitions.

The two phases of the overall evaluation criterion are static events and dynamic events. Design Evaluation, Sales Presentation, Cost Presentation, and CAE Presentation make up the static event. Static events include every area of the vehicle's design, including the use of proof-of-concept prototypes. Interactions and presentations with the judges take place during the static event. The judges review the FEA reports, spring and suspension calculations, brake and steering calculations, chassis calculations, drivetrain calculations, and spring and suspension calculations. Technical inspection of the vehicle is done during the static event to make sure it complies with the guidelines and specifications listed in the rulebook. The car is tested in challenging track circumstances during the dynamic events to assess its durability and manufacturing quality. Each team's car is put through a battery of tests, including brake, maneuverability, suspension, traction, and endurance.

Students create numerous techniques and performance testing rigs to keep up with rivals and the competition. A testing rig is a piece of equipment that, while under strict control, replicates the loads that the vehicle experiences in real life. To ensure there are no damages or injuries during the event, this is utilized to test the manufacturing quality of the car parts before to the event. The students create a variety of test rigs, some of which include engine test benches, braking system test benches, suspension system test benches, etc. for maximum performance. A student's knowledge, competence, and confidence graph during the competition increased exponentially, which helped them do better in academics as well.

2. LITERATURE SURVEY

The literature review on competition-based learning, which was compiled from numerous research articles and publications, is summarized below. To improve students' productivity and academic achievement, many schools and universities have adopted the CBL active curriculum. Numerous professors and students from various parts of the world have detailed cases for this.

F. A. PVN Saichandu,
Mechanical Engineering, Hyderabad Institute of Technology and Management, Telangana, India.
cponnekanti@gmail.com

V. Kosse and D. De Pellegrin (2004) from the School of Engineering Systems at the Queensland University of Technology in Brisbane, Australia, states that project-based learning (PBL) is often used in engineering courses. The project is more realistically based the more pertinent and in-depth the students' learning is. The Formula Society of Automotive Engineering (FSAE), where each student team develops and builds a tiny race car for competitive evaluation, is a great example of a team-based project focused on real-world issues. Queensland University of Technology (QUT) has taken part in FSAE Australia. Due to the project's success, QUT has even expanded its mechanical engineering degree to include a motor-racing specialization (second major). This paper discusses the advantages of teaching motor-racing engineering through practical projects as well as the challenges faced and solutions found. To verify the authors' opinions on the used teaching approaches, student responses were acquired using QUT's online LEX survey as well as a customized paper-based survey.

A Sino-Foreign Higher Education Institution in China (2009) claims that the goal of FSEC and other competitions linked tothe concept of Problem Based Learning is to advance students' skills and knowledge. The study focused on the advantages to the teaching and learning process while examining the viewpoints and opinions of those involved. The qualitative paradigm was employed for this process study because it emphasizes the human element, including ideas, thoughts, feelings, and personal experiences and perspectives on the FSEC. Student and staff interviews, process observations of activities, and a review of relevant activity documentation and literature were used to collect data. Five key themes underlining the advantages of FSEC for students' learning and experience were found through thematic analysis. The Formula Student project cultivates an atmosphere where students are highly driven to seek out information through active learning and are actively engaged with their peers and pertinent stakeholders, leading to a fulfilling educational experience. The research's findings will be used to organize future activities that involve competing, as well as to make sure that students' learning is integrated into their campus living experience.

D Chindamo (2016) from the University Degli Studi di Brescia in Italy claims that student competitions can have a big impact on education since they promote interest and participation from both students and teachers. The Moto student competition, which the University of Brescia (UniBS) entered for the first time, is one of the toughest contests in Europe for engineers. It is a famous example of how Kolb's theory of experiential learning is use, where engineering theory and application meet in a rigorous, "hands-on" cooperative experience, producing a learning process that is both highly effective and contains so-called soft skills. This paper's goal is to give a brief description of events like the Formula SAE and to discuss the writers' experience with a related competition called the Moto Student Contest.

Issa et al. (2014) stated that Competition-based Learning (CBL) is one of the ILOs used in a few learning models. A team of students working on an open-ended task with problems akin to those found in the workplace constitutes competition-based learning. However, after the prescribed task for the course is over, performance is assessed by other groups. This drive is utilized to dissuade students from "finishing it just to get it over with" thinking and to encourage them to think critically about their entire project. Additionally, a reward system is implemented following the completion of the required work. CBL can assist students to hone their critical thinking and problem-solving skills as well as their soft skills. Additionally, as the collaborative-based learning model allows students to share knowledge with other students by encouraging student participation, they can enhance their learning activities and outcomes.

3. METHODOLOGIES

Students of Mechanical Engineering are greatly impacted by motivation through vying, which pushes them to learn new things and work hard. The tasks range from leading seminars or webinars to providing hands-on instruction in 3D design software or vehicle construction. The club leaders engage in a number of these events before the competition. It takes an excellent team of designers, fabricators, managers, and a captain to compete and make a statement. The top team creates the best vehicle and maximizes its performance.

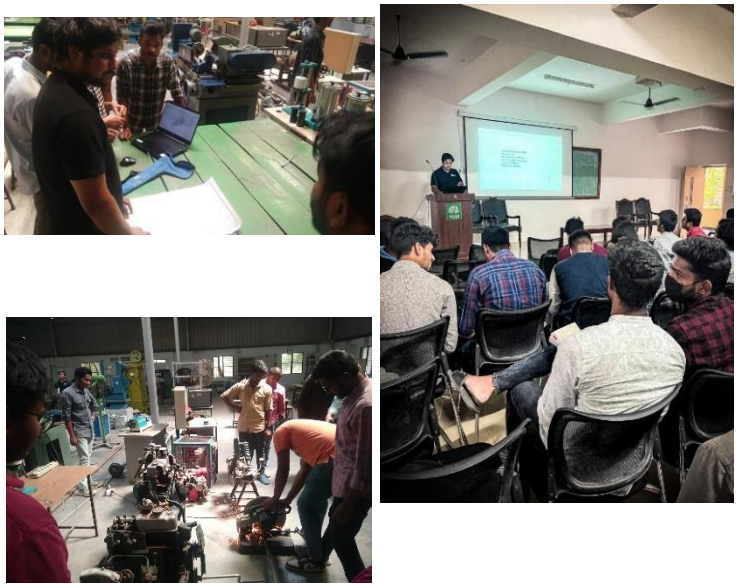


Fig-1: Technical Talk with Automotive Fabrication Mentors To identify the best team from

the university, the motorsports club and its activities are initially made known to the students through all the other clubs. After the pupils respond, tests and interviews are done to narrow down the responses. In the team, the shortlisted students are divided into several wings based on their areas of interest and expertise. The five wings of

design, manufacturing, testing, quality assurance and control, and business and marketing combine their skills to create the best

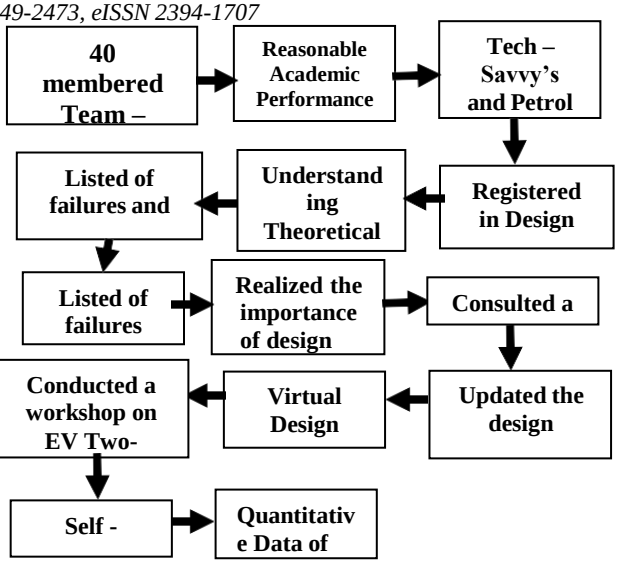
performance vehicle. The approach helps the students get a deeper understanding of a variety of engineering principles, including Strength of Materials, FEM, and CFD, among others. The Design wing receives training in 3D modelling software, design calculations, topology studies, writing reports, CAE reports, and proof of concept reports. The fabrication works necessary to build the vehicle is handled by the Manufacturing wing. The Business & Marketing division oversees producing B- plan reports, locating sponsors, and raising money from a variety of sources. The most crucial part of the team is the Testing wing. They put the car through the toughest tests to make sure it will hold up during the competition. Sensors and gauges are fastened to the components during testing. Future car models' design optimizations and topology studies both make use of the sensor data. By merging and sharing their expertise across all technical disciplines, the team creates and develops the vehicle, making them multi-domain experts.

To take part in design and development problems, a 25- member interdisciplinary team of 12 mechanical engineers, 5 electrical engineers, 3 electronics and communications engineers, and 2 computer science engineers formed. Those pupils who had trouble grasping the theoretical subject being taught in class joined the team. Previously, it was challenging for them to catch up with the classroom instruction where the rest of their classmates performed well. The students formed a racing team that dreams of creating a vehicle, developing it, and taking part in a design competition.

The team signed up for Automotive Fabrication competition 2018 Quad Bike design competition. Due to their sporadic attendance and lack of prior exposure to vehicle designs, the students lacked the theoretical understanding necessary to develop a trustworthy vehicle design. The team's experience was described, and the failures, disadvantages, and difficulties they encountered were compiled and valued. This time, the team prioritized theory understanding, design calculations, and vehicle design. The team was coached by a professor with 20 years of industrial experience to help them become more adept at analyzing and solving problems.

The validation of physical and virtual designs received more attention. Different technical principles, such as the strength of materials, machine design, and FEM, were needed to comprehend the outcomes and responses. The group used the mentor's assistance to conduct independent research using software, textbooks, journals, and technical videos. Students wereable to improve the design for better results because this helped them comprehend the outcomes and emotions.

v



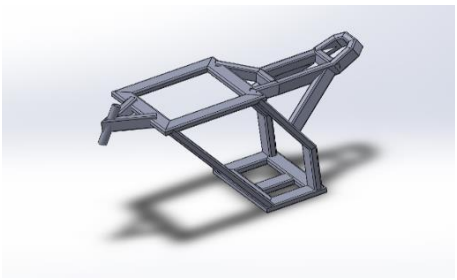


Fig-3: Chassis Assembly of EV Bike on CAD

Fig.4 – Fabrication by Automotive Fabrication Team

4. RESULTS & DISCUSSION

Data was analyzed before and after the competition to measure the performance of the students. Students and mentors participated in a survey that quantifies information about student conduct, academic performance, character, commitment, coordination, and motivation. The survey's questions and measurable findings are listed below

5. STUDENT SURVEY

1. Which engineering domain are you currently studying? (ME, CSE, ECE, EEE)

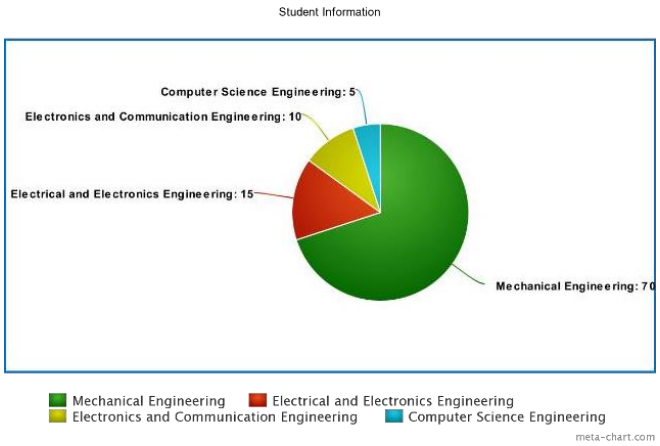


Fig-5

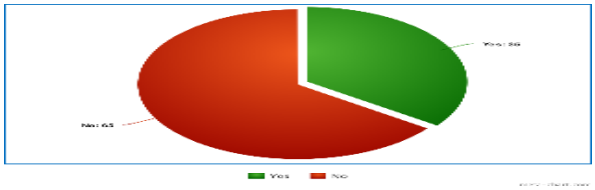


Fig-6

2. Are your current backlogs more than 6? (Yes, No)

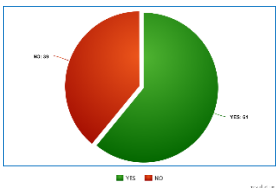


Fig-7

3. How do you characterize yourself among these options? (Introvert, Extrovert)

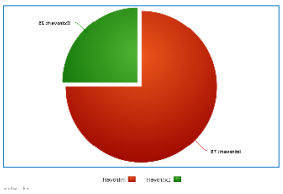


Fig-8

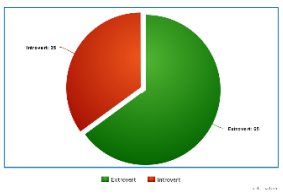


Fig-9

4. Do you have the technical knowledge of engineering concepts to build a vehicle? (Yes, No)

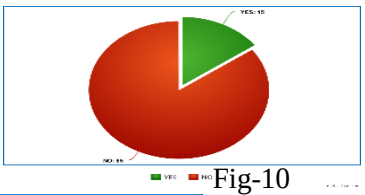


Fig-10

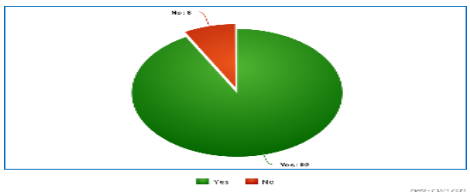


Fig-11

5. On a scale of 1-10 how much can you understand the engineering concepts by visualization (AVG)

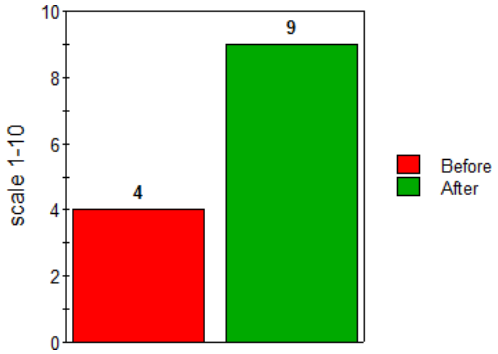


Fig-12

6. On a scale of 1-10 how confident are you to represent our institution in national and international events? (AVG)

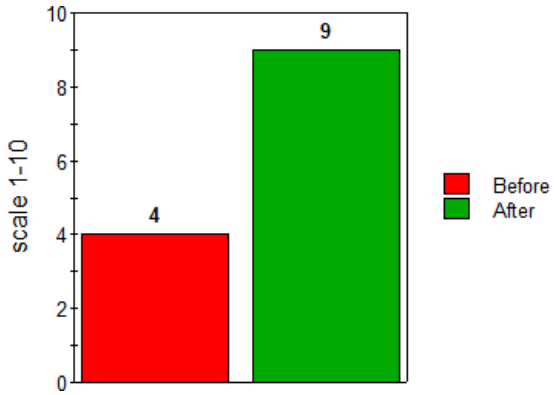
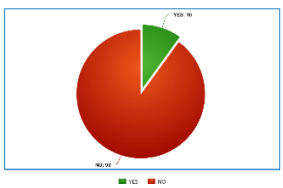
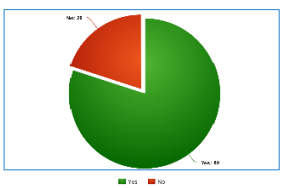


Fig-13

7. Do you call yourself a Multi-Domain Expert?

Fig-14 Fig-15





8. On a scale of 1-10 how much knowledge do you have of 3D design and modeling? (AVG)

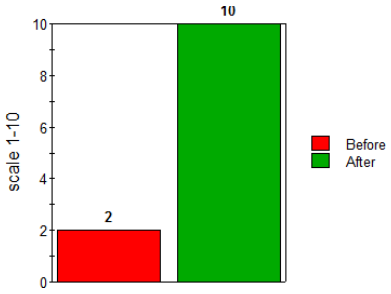


Fig-16

9. On a scale of 1-10 how much knowledge do you have on machining and manufacturing standards? (AVG)

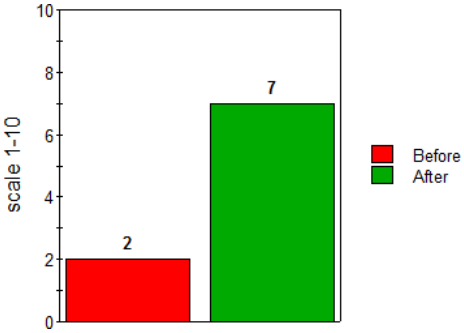
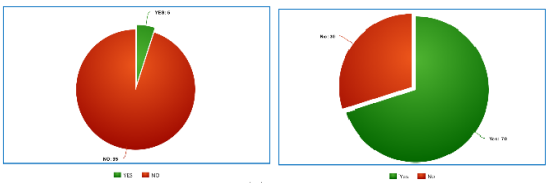


Fig-17

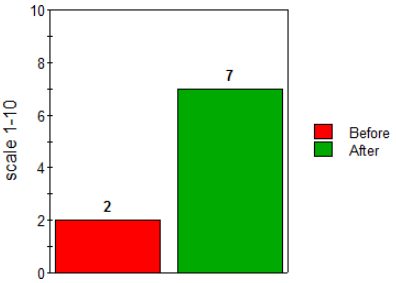
10. Do you have hands-on experience in manufacturing like welding, cutting, or grinding? (Yes, No)

Fig-18 Fig-19



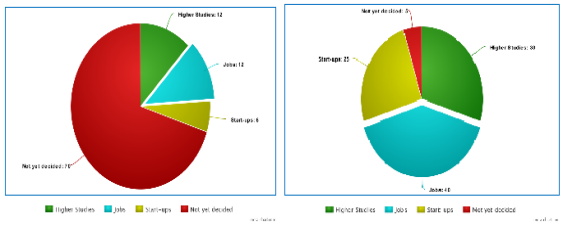
11. On a scale of 1-10 how well can you understand FEM and Motion Analysis?

Fig-20



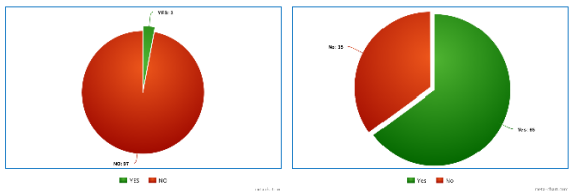
12. What are your future goals? (Higher Studies, Job, Start-up, Not yet decided)

Fig-21 Fig-22



13. Have you worked on research papers, patents, and products? (Yes, No)

Fig-23 Fig-24



6. MENTOR SURVEY

14. On a scale of 1-10 how friendly and open are students to their faculty and professors?

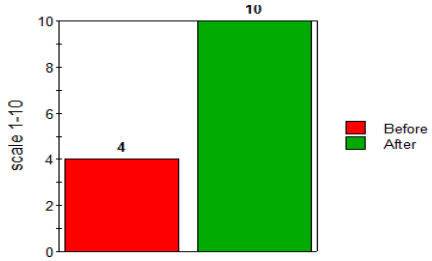
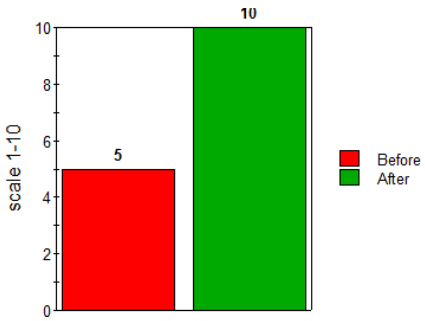


Fig-25

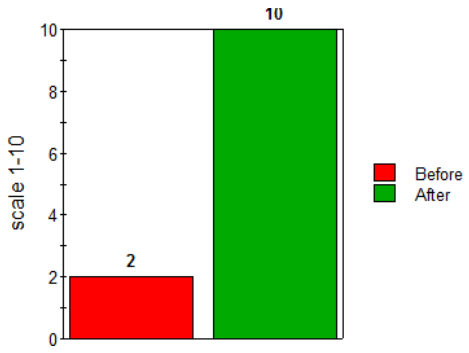
15. On a scale of 1-10 how committed the students are to the project and career?

Fig-26



16. On a scale of 1-10 rate the discipline of the students?

Fig-27



After analysing the data, it was evident that,

- The student's academic performance has increased exponentially and was able to clear the backlogs if there were any.
- The students were able to catch up with the classroom activities which they used to find hard earlier.
- This activity had a good impact on introverted students by increasing confidence in them and helping them to speak out in many.
- It was also observed that students were more committed than ever before and a few of them have gone to start their start-ups and got registered under Start-up India Scheme.
- The students were motivated and were also able to motivate other students and also trained the upcoming batches to keep the legacy of the team going.
- Not all students had a remarkable impact by following this process, most of the students have turned their lives around to have a successful career and few of them are still on the verge of achieving it.

7. CONCLUSION

Students' experiences in engineering education have been greatly impacted by Motorsports Club. Based on the statistics, it was evident that the students that competed had a broad understanding of several engineering subjects, which helped them succeed academically. The exercise has enhanced the students' capacity to picture concepts from mechanical engineering, such as material strength and FEM. As a consequence of competing, the students' self-esteem and problem-solving skills have grown. The student's resume will benefit from the competition-related exposure and experience, which will also help him stand out from other graduates. This also equips the learner to succeed in its competitive professional market.

Fig-28: EV Bike Designed and Manufactured by a team

8. REFERENCES

V. Kosse, D. De Pellegrin,(2011) "Teaching Tribology and Maintenance-related Subjects: a Hands-on Focus ", Proceedings of the 17th International Conference on Engineering Education: Engineering Sustainability for a Global Economy, ICEE,Northern Ireland, Belfast, pp. 1-8

Corina Joseph, Mariam Rahmat, (2019)" Factors Influencing the Effectiveness of the Competition Based Learning (CBL) Activity among Accounting Undergraduates ", International Business Education Journal Vol. 12 No. 1 Pg. 1-14

Pete Hylton and David J. Russomanno,(2014) " Motorsports Engineering: Bridging the Divide between Engineering and Engineering Technology with an Industry-Focused Curriculum ", Journal of Engineering Technology, Fall.

Sudershan Jetley and Anthony J. Palumbo, (2014)" Using Strategic Partnerships to Deliver Reality-Based Education ", Proceedings of The IAJC/ISAM Joint International Conference ISBN 978-1-60643-379-9.

M Gadola and D Chindamo,(2019) " Experiential learning in engineering education: The role of student design competitions and a case study ", International Journal of Mechanical Engineering Education , Vol. 47(1) 3–22.

Ghassan Issa, Shakir M Hussain, Hussein Al-Bhadili, (2014) " Competition-Based Learning: A Model for the Integration of Competitions with Project-Based Learning using Open Source LMS ", International journal of information and communication technology education, January DOI: 10.4018/ijicte.201401010.

N G S M Durgesh, Siva Prasad Kowdodi (2022), "Miniaturized Models in Engineering Education", International Mechanical Engineering Congress and Exposition, Proceedings of ASME 2022, October 2022.

Chepuri Sai Abhinav, Kowdodi Siva Prasad (2022), "Application of VTB in NPD – Suspension System in QUAD BIKE", Journal of Advancement of Machines, e-ISSn:2582-2233,Volume-8, Issue-3

PVN Saichandu (2018), "Impact of cognitive and collaborative learning on refrigeration & air conditioning course" Journal of Engineering Education Transformations

.