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PEDAGOGICAL ENHANCEMENT OF IMAGE PROCESSING THROUGH APPLIED MATLAB LEARNING

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Abstract: In today's competitive technological landscape, undergraduate engineering students must develop a blend of technical, analytical, and soft skills such as problem-solving, critical thinking, and design thinking. The ***research gap*** lies in the limited integration of practical, hands-on sessions within theoretically taught technical courses. The ***aim*** of this study is to investigate whether small, clearly defined in-class programming exercises can effectively expand students' critical and conceptual understanding. The ***methodology*** involved enhancing the Image Processing course—traditionally theory-based—by integrating compact, guided hands-on programming activities during lectures. The ***tools and techniques*** used included MATLAB® 2023 for coding-based exercises and Google Classroom for administering assignments, collecting data, tracking student progress, and analyzing feedback. These exercises were designed to strengthen mathematical foundations, problem-solving, and analytical reasoning skills while promoting application-oriented learning. The ***outcomes*** revealed that students demonstrated greater conceptual clarity, coding proficiency, and motivation to explore and modify their work beyond classroom requirements. Quantitative results indicated that 70–90% of students rated their understanding at higher levels (4 or 5) across key topics. Overall, the study confirms that integrating concise, practice-based programming exercises within theoretical sessions effectively bridges the gap between conceptual knowledge and practical application in engineering education.

Index Terms **- Critical Thinking, Education, Encouragement, Image Processing, Laboratory Session, Mathematical Foundations, Motivation.**

I. INTRODUCTION

According to data from leading sources [1]-[2], India produces about 1.5 million engineering graduates annually, with only around 10% being employable. The growing industrial demand for advanced skills in Artificial Intelligence, Machine Learning, Big Data Analytics, Cloud Computing, and the Internet of Everything has compelled technical institutions to strengthen their curricula through practical, skill-oriented learning [3]. Over the past decade, engineering education in India has evolved from passive theory-based instruction to a creative, practice-driven system [4], enhancing students' numerical understanding, real-life problem-solving abilities, and multidisciplinary thinking [5].

Implementing such reforms in diverse classrooms demands innovative teaching strategies beyond traditional lectures—such as in-class experiments, participative learning, coding assignments, guest lectures, industrial visits, and project-based activities [6]. This work attempts to embed compact hands-on MATLAB programming exercises within the Image Processing course to enhance students' critical thinking and analytical skills.

The study aims to: (i) present the course objectives and outcomes, (ii) demonstrate the design and integration of coding-based sessions into theory lectures, and (iii) highlight student feedback and learning improvements. The objectives were implemented over six months, addressing the central research question: ***Can small, well-structured in-class programming exercises enhance students' critical and conceptual understanding?***

Section 2 explores the literature to understand the existing direction of work. The aim of this section is to build upon the existing work, introduce the implemented methodologies, tools and techniques, advantages and disadvantages of the work and frame the research gaps. **Section 3** explores structured course objectives, outcomes, and detailed session planning that were designed and implemented to enhance teaching-learning experiences. **Section 4** discusses the questionnaire given to students, students feedback and the observations and conclusions inferred. **Section 5** is conclusion and future directions

II. LITERATURE REVIEW

Year & Ref. No.	Research objectives	Research methodology	Work done	Research gaps
2006 [7]	To foster critical thinking (CT) skills within the time and resource constraints of traditional classroom settings.	Integration of online instructional tools and strategies	Addresses a long-standing pedagogical challenge—how to foster CT within systemic and temporal constraints—making it especially pertinent in the context of modern, digitally enriched education.	It lacks **empirical validation** through large-scale classroom implementation or quantitative assessment of learning outcomes.
2013 [8]	To understand the interplay between social engagement, cognitive development, and learning outcomes in digitally mediated environments.	Employed a quantitative research design supported by Structural Equation Modeling (SEM) to empirically validate the proposed conceptual framework	Developed a model combining Social Cognitive Theory and Learning Input Factors to assess how cognitive skills affect learning in Saudi e-learning systems.	Lacks qualitative insights (e.g., interviews or open-ended feedback) to deepen understanding of learner attitudes and behaviors.
2013 [9]	Proposed a model integrating critical reflection, design thinking, and situated learning to develop integrative, adaptive learners.	Conceptual framework combining critical management theory with design thinking for experiential, student-centered learning.	Innovative blend of theory and practice; promotes real-world, experiential learning.	Lacks quantitative validation and longitudinal assessment of learning outcomes.
2017 [10]	Examined how faculty trained in critical thinking (CT) programs integrate CT strategies into teaching and their impact on student learning	Mixed-methods explanatory sequential design with pre- and post-test data from 133 students; analyzed using dependent *t*-tests.	Mixed-methods approach provides comprehensive insight; strong empirical validation of CT skill improvement.	Reliance on recall-based questions limits assessment of real-world CT application and knowledge transfer.
2018 [11]	Explored the role of higher-order thinking skills (HOTS) assessment in fostering critical thinking among mathematics students.	Developed and validated HOTS-based test instruments aligned with CT indicators through expert review and empirical analysis."	Provides valid and reliable tools for assessing HOTS; offers a structured framework to evaluate students' critical thinking in mathematics.	Highlights limited use of HOTS-based assessments in current mathematics education practices.
2019 [12]	Examined whether structured training can enhance higher education teachers' critical thinking (CT) skills and attitudes toward teaching CT	Used a quasi-experimental design with pre-, mid-, and post-tests across three sessions integrating reasoning bias instruction and applied teaching practice	Focuses on CT development for teachers; rigorous design with measurable improvement and replicable methodology.	Possible self-selection bias; lacks assessment of long-term retention and practical application.
2020 [13]	Conducted a systematic literature review to develop a conceptual framework addressing key debates in teaching critical thinking (CT): where, what, how, and with what tools CT should be taught.	Systematic review and synthesis of theoretical and empirical studies on CT instruction, assessment, and technology integration.	Provides a structured framework around four major debates; comprehensive coverage of CT theories, strategies, and assessments with practical pedagogical insights.	Lacks empirical testing of the proposed framework and comparative analysis across disciplines or educational levels.
2021 [14]	Examined an Integrated Teaching Methodology (ITM) blending peer learning, technology, and lectures to improve conceptual understanding in large physics classes	Used a quasi-experimental design contrasting ITM and lecture-based groups; found 110–150 minutes of peer learning most effective	Demonstrated significant improvement in conceptual understanding; validated ITM's applicability in large class settings, addressing scalability concerns of active learning.	Limited to short-term outcomes; lacks longitudinal analysis of knowledge retention and transfer across courses or disciplines.
2021 [15]	Explored how higher education (HE) teachers in the Global South promote critical thinking skills (CTS) among students in business management and vocational studies.	Mixed-method approach using surveys and interviews with 55 experienced HE teachers from 26 countries; data analyzed thematically.	Showcases Global South perspectives and emphasizes learner-centered, active, and problem-based approaches reinforced by genuine educator feedback.	Findings are perception-based; lacks quantitative measurement of CTS development or longitudinal assessment of instructional impact.
2022 [16]	Investigated how digital tools can support the	Implemented project-based learning with	Empirically validated effectiveness of digital	Limited to two digital tools and a small

	development of critical thinking (CT) skills among future teachers and lawyers in higher education.	Online Test Pad and MindMeister among 156 students from two Russian universities; results were statistically evaluated.	tools in enhancing CT; used accessible, non-programming platforms and mixed participant profiles, improving generalizability.	sample size, restricting broader applicability.
2023 [17]	Constructed and validated a model combining Social Cognitive Theory and Learning Input Factors to analyze the impact of reflective, inquiry-based, problem-solving, and critical thinking skills on e-learning performance in Saudi higher education	Quantitative research using Structural Equation Modelling (SEM) to empirically validate relationships between social-cognitive and learning constructs.	Strong theoretical integration; rigorous empirical validation through SEM enhances credibility of findings.	Lacks qualitative insights such as interviews or open-ended feedback to explore students' attitudes and behaviors in depth.
2023 [18]	Evaluated the effectiveness of Team-Based Learning (TBL) in improving nursing students' problem-solving and critical thinking skills.	Systematic review of six quantitative studies (2 RCTs, 4 quasi-experimental) with 936 nursing undergraduates from South Korea and the U.S., applying Team-Based Learning based on Michaelsen and Sweet's 4S framework	Demonstrated TBL's positive impact on problem-solving, student engagement, collaboration, and self-directed learning.	Inconsistent statistical significance in CT gains; high preparatory demand for educator's limits scalability.

Research gap: Despite strong theoretical and empirical progress, existing research still lacks- Holistic, mixed-method validation combining quantitative rigor and qualitative depth and scalable, cross-disciplinary frameworks that can integrate critical thinking development seamlessly into digital and traditional learning environments.

Contributions: This paper makes a sincere effort to incorporate seamless integration of theoretical learning with practical implementation, particularly using MATLAB-based exercises to enhance the learning experience of the students for the course of image processing. The succeeding section briefs about the implemented methodology. The study supports enhanced learning performance, as students achieve higher levels of understanding.

III. RESEARCH METHODOLOGY

Image Processing is a third-year elective in the B.E. (Information Technology) program under the University of Mumbai (UoM), designed per AICTE's Outcome-Based Education (OBE) framework. The course follows the Choice Based Credit and Grading System (CBCGS), emphasizing learner-centric and continuous evaluation. It carries three credits with three contact hours per week over fifteen weeks and requires prior knowledge of logic algebra, matrix manipulation, and digital signal processing.
Traditionally taught through lectures using whiteboards, presentations, and videos, the course revealed key gaps-

- Insufficient practical and visualization skills – Students could not translate theory into software-based implementation.
- Low engagement and surface learning – Teacher-centric delivery reduced participation and conceptual flexibility.
- Limited critical thinking – Students struggled to apply knowledge to real-world image processing problems.
- Lack of exposure to modern tools – Minimal hands-on experience with current image processing technologies.

The adopted research methodology is fragmented into three sections. The section 3.1 provides information about the list of participants with their associations and the research tools. Section 3.2 discusses the design procedures of course objectives and outcomes. Section 3.3 further discusses the design structure of in class programming exercises mapped to the outcomes.

3.1 Participants, Tools and Technologies

Participants: The image processing course is offered as an elective subject in the third year of the undergraduate Information Technology engineering program. St. Francis Institute of Technology (www.sfit.ac.in) is an autonomous engineering college affiliated to University of Mumbai. Accordingly, all participants in this study were third-year undergraduate students enrolled in the Information Technology program at St. Francis Institute of Technology, Mumbai for the academic year 2024-25 (even semester). A total of 46 participants were enrolled for the course-17 girls and 29 boys. The age group of the students is 20-21 years. The course content has 6 modules that was entirely covered in 39 lectures.

Study Design: The in-class programming exercise were programming experimental based.

Materials and Procedure: MATLAB® 2023 (MathWorks) was employed as the main programming tool. Students were guided to create online accounts on MATLAB Online (https://www.mathworks.com/products/matlab-online.html). After theoretical concepts were introduced, in-class programming activities were carried out to strengthen practical understanding. At the conclusion of each session, feedback was collected through Google Forms (https://support.google.com/a/users/answer/9303071?hl=en) to assess students' understanding of the topics covered. The Google form containing the questionnaire was filled by the students and submitted online.

3.2 Design of Course Objectives and Outcomes

The three fundamental step towards design, development and conduction of any course are -syllabus setting, framing course objectives and course outcomes and session planning. Structured and curated syllabus [19] provides transparency, solid structure and evidentiary to the students. The course objectives [20] focus on teaching process and hence describe the flow of content. It also contours the skill sets the students will gain over the course period. The course outcomes help the instructors to plan the content for systematic completion and provides course expectation clarity to the students. Session planning [21] provides in-depth details about planned date of conduction, details of the portion that is planned to be conducted, teaching pedagogy and tools that that will be used. Table 1 was design and document for a structured and outcome-driven teaching plan for the Image Processing course. The construction of such table also helped integrate theoretical concepts with practical, hands-on exercises and provide a reference framework for incorporating continuous improvement in teaching methodologies.

Table 1. Chapter title, significance and course objectives and outcomes

Chapter Title	Significance	Course Objectives and Outcomes
Introduction to Image Processing	▪ Outlines the need, types of images, applications and advantages. ▪ Defines different steps like-Image acquisition, image enhancement, image transforms etc ▪ Enables students to understand how a digital image is represented using matrix ▪ Enables students to understand the need and methodology for digitization of raw images. ▪ Develops the mathematical foundations to help relate the pixels and analyse images.	*Objective 1:* To discuss the fundamentals of image processing [22]. *Course Outcome CO1:* Define image, explain formation of image and recall its types and calculate image parameters by reading images using programming languages [22].
Image Enhancement	▪ To describe the mathematical foundations and practise the application for various point processing and mask processing-based image enhancement techniques. ▪ Helps students to analyse the spread of intensity levels in a given image.	*Objective:* To study, understand and implement image enhancement techniques [22]. *Course Outcome CO2:* Apply and differentiate point, mask and histogram processing techniques suitable for enhancing images required for an application [22].
Image Transforms	Helps students to understand the mathematical formulation and need for transforms like- DFT, DCT, DHT and DWT for applications in- ▪ Image compression techniques ▪ Noise reduction and filtering ▪ Image enhancement ▪ Pattern and object recognition	*Objective:* To understand and implement image transform functions and their applications [22]. *Course Outcome CO3:* List and calculate discrete image transforms coefficients and use it for enhancement compression and representation [22].
Image Compression	This chapter is directed towards theoretical concepts and numerical solving related to Run-Length Coding, Huffman Coding, Arithmetic Coding, LZW Coding, Bit Plane Coding, Symbol-Based Coding and Vector Quantization.	*Objective:* To study, interpret and apply different image compression techniques [22]. *Course Outcome CO4:* Compute compression ratio and fidelity criteria to evaluate and compare methods efficiency and classify compression techniques into lossless and lossy methods [22]
Image Segmentation and Reconstruction	This chapter deals with segmentation techniques applied for point, lines and edges which can be applied to – ▪ Efficient image data processing ▪ Object detection and tracking ▪ Image reconstruction for quality improvement	*Objective:* To discuss and demonstrate different image segmentation techniques [22]. *Course Outcome CO5:* Apply the segmentation techniques to highlight and select the region of interest and determine and describe using chain code, shape number and moments for representing objects in an image [22].
Morphological Image Processing	This chapter deals with basic morphological operations like erosion, dilation, opening, closing and hit and miss transform. The chapter also focuses on advanced topics like thinning, thickening, pruning and boundary extraction.	*Objective:* To discuss and demonstrate different morphological image processing techniques [22]. *Course Outcome CO6:* Choose structuring elements and apply morphological operations to find a suitable shape for an object in the image [22].

3.3 Design of In-Class Programming Exercise

Design of programming exercises: To address the aforementioned drawbacks and effectively align with the course objectives and outcomes, numerous concise and focussed programs (*called as in-class programming exercises*) using MATLAB 2023® were developed and integrated with the topics of each chapter. The in-class programming exercise were purely introduced to comprehend better understanding of the topics covered in the syllabus and were not evaluated for examination purposes. The complete list of topics, mapped MATLAB2023® programs and their learning outcomes are as listed in Table 2.

Table 2. Chapter title, significance and course objectives and outcomes

Chapter Title & Mapped CO	Program Title (PT) (Coding Exercise)	Concept Explained and Demonstrated	Skills Developed
Introduction to Image Processing *Mapped Course Outcome: CO1*	PT1: Write a program in MATLAB to read and display an image. [Binary, grey and color]	▪ Matrix representation of image. ▪ Concept of size of image ▪ Concept of pixel and intensity ▪ Concept of grey levels of an image	Programming, interpretation, debugging, attention to details.
Image Enhancement *Mapped Course Outcome CO2*	PT2: Write a program in MATLAB to perform image negation.	The concept of image negation	Visualization and interpretation.
	PT3: WAP in MATLAB/Python to implement the concept of bit plane slicing	▪ The concept of bit plane slicing, Least Significant Bit (LSB). ▪ Most Significant Bit (MSB), Compression.	In-depth bitwise understanding of digital image representation, critical thinking, advanced visualization.
	PT4: WAP in MATLAB to implement the concept of contrast stretching and thresholding	▪ Concept of dynamic range in an image. ▪ Linear and non-linear transformations. ▪ Importance of min and max. values and feature extraction.	Simplifying complex data to focus only on relevant data, decision making and classification.
	PT5: WAP in MATLAB to implement the concept of noise. Add gaussian noise and salt and pepper noise	▪ Real world imperfections in image, different types of noise present in image. ▪ Quantitative thinking of SNR, MSE, PSNR. ▪ Normal distribution, sudden distribution.	Visual and statistical analysis skills, simulation skills, data set creation skills.
	PT6: WAP in MATLAB to implement the concept of filters in image processing	▪ Deep theoretical understanding and practical skills. ▪ Different types of noise, trade-off between smoothing and losing information.	Algorithm development, real world application understanding, critical thinking.
	PT7: WAP in MATLAB to perform histogram equalization	▪ Distribution of pixel intensities. ▪ Probability and cumulative distribution concepts. ▪ Redistributions of image intensities.	Context and adaptability of an image, analyse transforms programmatically.
Image Segmentation and Reconstruction *Mapped Course Outcome CO5*	P8: WAP in MATLAB for line detection	▪ Concept of object, shapes and regions. ▪ gradient analysis, intensity changes, edge maps. ▪ Hough transforms, noise handling and preprocessing.	Key operators, visualization and interpretation skills, Foundations of advanced computer vision.
	P9: WAP in MATLAB for edge detection		
	P10: WAP in MATLAB to perform region-based segmentation	Concept of homogeneity, region growing, region splitting, region merging, split and merge.	

Implementation methodology: These in-class programming exercises were conducted over a period of 14 weeks. Since the students lacked prior knowledge of MATLAB programming, fundamental concepts were taught before the actual class sessions began. The programming concepts and the applications of the implemented functions, were explained before the conduction of the designed programming exercises. This helped to blend the programming concepts very easily with the theoretical concepts taught in class making the lectures highly engaging and interactive.

Proposed outcomes: The approach is designed to supports outcome-based education by enabling measurable assessment of learning achievements, while also guiding curriculum design, promoting continuous improvement, and preparing students for real-world applications in image processing.

IV. RESULTS AND DISCUSSIONS

4.1 Results and observations

In this section focusses on the questions asked in the feedback and percentage distribution of the results. The entire findings are represented in Table 3.

Table 3. Feedback questionnaire, results and critical observations

Sr. No.	Question Asked Feedback	Parametric Choices	Results (%)	Critical Observations
1.	Why did you choose the course of image processing	Degree requirement	1.8	It is observed that 44.4% of the students found the subject interesting to pursue because it offers a good blend of theory and mathematics. It then becomes the responsibility of the educator to uphold this interest alive
		Subject with a good blend of mathematics and theory	44.4	
		Interested to learn something new	52.8	
		Friends took the course	1.0	
2.	On a scale of 1-5, how well did the in class experimental sessions meet your expectations?	1-Poor	….	It is observed that the responses to this question is equally divided between good, very good and excellent.
		2-Fair	….	
		3-Good	27.8	
		4-Very good	36.1	
		5-Excellent	36.1	
3.	Were the objectives of in class experimental sessions clearly stated for each of the modules of course.	1-Strongly disagree	….	The combined 86.1% agreement suggests that most students found the objectives clear, though a small neutral segment (11.1%) may indicate areas where clarity could be improved.
		2-Disagree	2.8	
		3-Neutral	11.1	
		4. Agree	52.8	
		5. Strongly agree	33.3	
4.	Did the in class experimental session help you corelate and understand the mathematical formulation well for the all the modules	1-Strongly disagree	….	Over 91% of the students had positive learning experience. The lack of negative feedback reinforces the strength of the teaching method.
		2-Disagree	….	
		3-Neutral	8.3	
		4. Agree	44.4	
		5. Strongly agree	47.2	
5.	Did the in-class experimental session help you develop critical thinking for all the modules	1-Strongly disagree	….	88.9% of students responded positively, indicating that the session was effective in promoting critical thinking skill.
		2-Disagree	….	
		3-Neutral	11.1	
		4. Agree	66.7	
		5. Strongly agree	22.2	
6.	On a scale of 1 to 5, how well did you understand the concept of contrast stretching using MATLAB. Scale 1=Not at all, 5=Extremely well	1-Not at all	….	With over 70% rating their understanding at the higher end of the scale and no low ratings, the instructional methods appear effective.
		2- Small extent	….	
		3-Moderate extent	27.8	
		4-Great extent	52.8	
		5-Extremely well	19.4	
7.	On a scale of 1 to 5, how well did you understand the concept of Histogram equalization using MATLAB?	1-Not at all	….	A strong majority (86.1%) of students rated their understanding at level 4 or 5, suggesting that the instructional approach was highly effective for this concept.
		2- Small extent	2.8	
		3-Moderate extent	11.1	
		4-Great extent	47.2	
		5-Extremely well	38.9	
8.	On a scale of 1 to 5, how well did you understand the concept of different types of noises present in an image?	1-Not at all	….	A majority (72.2%) of students rated their understanding as good to excellent, confirming the effectiveness of the teaching method. About 27.8% showed moderate understanding, indicating minor scope for reinforcement, while none reported poor comprehension.
		2- Small extent	….	
		3-Moderate extent	27.8	
		4-Great extent	36.1	
		5-Extremely well	36.1	
9.	On a scale of 1-5 how well you understood the concept of applying filters to images using MATLAB programming	1-Not at all	7.4	A strong majority (74%) of students rated their understanding of image filtering as good to excellent, while 18.5% showed moderate
		2- Small extent	….	
		3-Moderate extent	18.5	
		4-Great extent	40.7	

		5-Extremely well	33.3	understanding, indicating minor scope for further practice.
10.	On a scale of 1 to 5, how well did you understand the concept of bit plane slicing	1-Not at all	….	A strong majority (83.4%) of the class rated their understanding as good to excellent (4 or 5), indicating that the teaching method for bit plane slicing was highly effective
		2- Small extent	….	
		3-Moderate extent	16.7	
		4-Great extent	41.7	
		5-Extremely well	41.7	
11.	On a scale of 1-5 how well you understood and implemented the concept of line and edge detection using MATLAB programming.	1-Not at all	….	A majority (62.9%) of students showed strong understanding of line and edge detection, while 22.2% had an average grasp and 14.8% faced difficulties, indicating the need for additional guidance and hands-on practice.
		2- Small extent	14.8	
		3-Moderate extent	22.2	
		4-Great extent	29.6	
		5-Extremely well	33.3	

4.2 Discussion-Result interpretation

Part 1: General – Combined Conclusion: The overall findings reveal that 52.8% of students enrolled in the Image Processing course out of curiosity to explore new concepts, while 44.4% were attracted by its blend of theory and mathematics. This indicates that most students were intrinsically motivated, underscoring the importance of maintaining such curiosity through well-balanced, practice-oriented learning experiences. Notably, nearly 66% rated the experimental sessions as engaging and insightful, reaffirming the value of integrating practical exposure within theoretical courses.

Part 2: Instructional Effectiveness – Combined Conclusion: Regarding instructional effectiveness, student feedback strongly endorsed the clarity and impact of the in-class programming sessions. About 86.1% of respondents agreed or strongly agreed that the session objectives were clearly communicated, while 88.9% acknowledged significant improvement in their critical thinking skills, with no negative responses. The small proportion of neutral feedback suggests a minor need to better articulate learning objectives at the beginning of each session.

Part 3: Subject-Level Understanding – Combined Conclusion: At the subject level, most students achieved high conceptual understanding across key topics such as histogram equalization (86.1% rated level 4 or 5), bit-plane slicing (83.4%), and image filtering (74%). Even for complex topics like edge detection, 62.9% rated high understanding, and none reported complete lack of comprehension. However, a consistent subgroup (≈15–30%) remained at moderate proficiency, highlighting the need for differentiated instructional support. Incorporating guided examples, scaffolded exercises, and real-world problem applications can further consolidate learning and ensure sustained engagement across varying skill levels.

4.3 Impact on end semester examination

The End Semester Examination (ESE) for the Image Processing course is conducted after 16 weeks of instruction, carrying a total of 80 marks, with 32 marks as the minimum passing criterion. A comprehensive result analysis for Academic Years (AY) 2024–25 and 2023–24 was carried out to evaluate the impact of the in-class programming exercises on student performance. Table 4 presents the detailed result statistics. Section I outlines the number of students enrolled, passed, and failed, along with the corresponding pass percentages for both academic years. Section II provides the category-wise mark distribution, grouped as: >70, 60–69, 50–59, 40–49, 32–39, and <32 marks. This comparative analysis helps assess both overall performance trends and the shift in higher achievement bands following the introduction of in-class programming activities.

Table 4. Result analysis for the AY 2024-25 and 2023-24.

Section-I					Section-II					
Academic Year	**Enrolled students**	**Pass**	**Fail**	**% Pass**	**> 70 Marks**	**70-60 Marks**	**59-50 Marks**	**49-40 Marks**	**40-32**	**<32**
2024-25	46	46	0	100	S[1]=22 P[2]=47.82 %	S=13 P=28.26 %	S=8 P=17.39%	S=3 P=6.52%	0	0
2023-24	37	36	1	97.3	S=14 P=38.88 %	S=10 S=27.77%	S=7 P=19.44%	S=5 P=13.88%	0	1

1=No. of students2=Pass percentage

From the Table 4, the following points can be effectively concluded-Pass rate improved from 97.3% (2023–24) to 100% (2024–25). The proportion of students securing distinction (>70 marks) increased considerably from 38.88% in 2023–24 to 47.82% in 2024–25. Similarly, the share of students in the 70–60 marks range remained relatively stable (27.77% in 2023–24 compared to 28.26% in 2024–25). A decline was observed in the lower categories: students in the 59–50 marks range decreased from 19.44% to 17.39%, and those in the 49–40 marks range reduced from 13.88% to 6.52%. Notably, no students fell below the 40-mark threshold in AY 2024–25, while AY 2023–24 recorded one failure (2.77%).

V. CONCLUSIONS AND FUTURE DIRECTIONS

By integrating theoretical concepts with hands-on MATLAB programming tasks, students were encouraged to develop a deeper understanding of key image processing techniques such as convolution, histogram analysis, logical operations, and geometric transformations.

The combined results highlight that over three-fourths of students consistently rated their learning experiences at higher levels (4 or 5) across modules. Across all modules, the integration of in-class experimental sessions with lectures yielded consistently positive outcomes. The absence of widespread low ratings indicates that the teaching approach was broadly effective. However, topics such as contrast stretching, image filtering, and line/edge detection showed pockets of moderate to low confidence, suggesting areas where supplemental exercises, additional examples, or remedial sessions may be introduced.

As future direction to the work done, the model can be implemented for more courses using modern teaching tools. Additional reinforcement through *extended practical sessions* or *tutorial-based support* for complex modules, more iterative assessments and incorporation of real-world case studies or projects to strengthen application-based learning

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