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THE IMPACT OF DIFFERENT COMPUTING TOOLS IN ELECTRICAL ENGINEERING LEARNING

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Abstract

The objective of this study is to assess the use, impact, and issues related to the application of computing devices in Electrical Engineering learning by students in Pakistan. With the ever-increasing infusion of technology in engineering disciplines, it becomes necessary to examine the contribution of computing tools like MATLAB, Simulink, Python, etc. on understanding, application, and readiness for industrial demands. The current study adopted a quantitative strategy by using a pre-tested questionnaire with 400 randomly chosen students enrolled in the Electrical Engineering program across government and private universities in Pakistan. The survey recorded demographic information, frequency of tool utilization, methods of learning, perceived effectiveness of the methods, and challenges encountered. Data analysis procedures were conducted using SPSS Version 29 where frequencies and percentages were computed along with the generation of bar and pie charts, radar diagrams, and tables, all of which fell under descriptive statistics. The results suggest that MATLAB (80%) and Simulink (62.5%) are the most popular and considered the best tools in engineering courses. Most of the students completed these tools to be helpful or extremely helpful in learning; however, significant issues such as no training (62.5%), software cost (50%), and complexity (45%) posed problems. Although most students reported university courses as their primary learning source (75%), they also resorted to self-study, online videos, and studying with friends. Furthermore, students proposed including additional modern technologies like sophisticated Python for AI/ML and PLC programming in the curriculum. This research examines the relevant literature and integrates computing resources within the context of Pakistani Electrical Engineering programs, which has previously been documented in the region. It documents the gaps in tool-imbedded pedagogy, and offers engineering education improvement recommendations through curriculum change, formative evaluation, and infrastructure development.

Keywords:
Electrical Engineering Education, Computing Tools, MATLAB, Quantitative Study, Curriculum Integration

I. INTRODUCTION

The use of computers and other technology in electrical engineering has changed how instructors teach the subject and how students learn to innovate and apply electrical engineering in practice. During the evolution of electrical engineering due to the rapid upgrade of technology, the use of computers became a necessity for both theory and practice. This means there is a need for schools to change their approaches and curricula to integrate these resources to avail them and prepare students for the realities of employment in engineering.

In the past, electrical engineering instruction focused heavily on practical/manual calculations, mental derivations, and performing physical experiments in theory labs [18]. These techniques provided students with an excellent grounding, but constrained the amount of experimentation and the level of system complexity, which could be analyzed from an academic perspective [3]. The availability of computing technology has enabled students to not only simulate intricate circuits but also analyze colossal amounts of data, as well as view electromagnetic fields in ways that have previously not been possible. These advancements, coupled with enhanced comprehension skills, have paved the way to foster an even more innovative learning environment [26].

Instructors value a broad range of computers for teaching electrical engineering, but MATLAB, specifically for its exceptional qualities as a numerical computing environment, stands out among the rest [16]. Its adaptability enables students to create models of dynamic systems, carry out signal processing, and design control systems, which supports many sub-disciplines in electrical engineering [13]. Likewise, SPICE (Simulation Program with Integrated Circuit Emphasis) simulates and analyzes both analog and digital circuits, providing students with valuable simulations pertaining to the behavior of circuits. These systems improve the understanding of the theory, but also provide the practical skills that are essential in the professional world [9].

The development of virtual laboratories as new types of learning resources has been a remarkable advancement in hands-on learning [24]. India's Virtual Labs project offers advanced educational laboratories online, letting students conduct simulations as well as analyze the results in real-time. Having access to these resources broadens educational opportunities, particularly for disadvantaged schools that do not have well-equipped laboratories, and allows students to seamlessly engage in hands-on practice no matter where they are located [20].

Another shift in electrical engineering education makes use of artificial intelligence (AI) technologies integrated into learning tools. AI applications help in custom tailoring learning experiences to specific students, thereby creating individualized study plans [11]. For example, prompt-dependent intelligent tutoring systems can evaluate one's level of expertise on the subject and adjust the problem sets accordingly to provide the best linear progression towards optimal learning. With customized approaches towards education, participation, retention, and mastery of intricate concepts improve effectively [29].

The application of single-board computers (SBCs) in education such as with the Raspberry Pi and Arduino has added a new dimension to learning [2]. These devices are so inexpensive, flexible, and easy to use that they enable students to come up with prototypes. The process of designing and constructing circuits provides hands-on experience so students can better understand core electrical concepts and appreciate how different systems work together [19].

Integrating these computing resources into the curriculum is also coordinated with new demands emerging from the industry. As employers consider new graduates, there is an increasing need for those trained in modern computer-aided simulation, programming, and data processing, which are becoming essential skills for virtually every branch of engineering. Therefore, it is up to educational institutions to enable students to acquire these skills and competencies in such a way that they will be able to practice smoothly after leaving school [25].

The obstacles posed by the incorporation of computing tools are quite the opposite. Teachers have to deal with how steep the learning curve is for the more advanced software, the level of access students have to the technology, and how current class materials are per the most recent developments in the area [12]. There is also the need to ensure that a suitable balance is struck between the computer skills students require, and the basic theory, so there is not an overreliance on software [6].

The effects of modern computing tools on electrical engineering education are deep and complex. These tools have broadened the scope of learning, fostered innovation, and synergized educational outputs with industry needs. It is critical, with the advancement of technology, that pedagogical structures ensure learners train to not only use existing technologies but also pioneer future innovations in a world destined to evolve.

A. Problem Statement

Although the use of computing tools in teaching electrical engineering is on the rise, there is still no comparative analysis on their use and their impact on student learning outcomes. Many educational institutions integrate these tools without prior assessment of their educational value, resulting in uneven benefits to schooling. This gap Impede development and limited student industry expectant the adequacy of curriculum obscures informed curriculum development and students' preparedness for industry demands. Thus, a systematic study is required to evaluate the impact of various computing tools on learning efficiency, skill, and concept acquisition in engineering practice.

B. Objectives of the Study

1. To evaluate the effectiveness of various computing tools (e.g., MATLAB, SPICE, Arduino) in enhancing conceptual understanding and problem-solving skills among electrical engineering students.
2. To compare student engagement, performance, and learning outcomes across courses that incorporate different computing tools.
3. To identify the challenges and best practices associated with integrating computing tools into electrical engineering curricula.

II. LITERATURE REVIEW

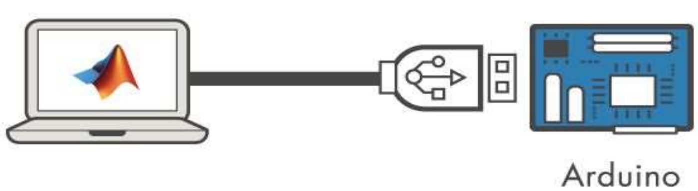
A. Integration of Computing Tools in Engineering Education

The use of computing technology in electrical engineering education, like many other disciplines, has been growing over the years, particularly as schools and universities shift toward digitalization. This marks the fifth evolution in the teaching of engineering, which incorporates information, communication, and computation technologies (ICCT) into the curriculum. Traditional practices, such as numerically solving problems, have been superseded by computational methods due to their greater efficiency [15].

Computing resources aid in capturing students' attention while providing a hands-on approach that enables them to grasp more intricate ideas deeply [8]. As an example, the article discusses microcomputers employed as teaching aids and their positive imacts on the pedagogical process. In addition, the incorporation of tools of Education 4.0, such as interactive simulation and AI-assisted teaching technologies, has been favorable to students' attitudes and comprehension of the material, particularly in electrical circuits [7].

B. MATLAB and Simulink in Electrical Engineering Education

Simulink and MATLAB have applications in the education of electrical engineering focuses like computing circuit diagrams, signal processing, and control system design. They offer modeling and simulation environments that are helpful in the visualization and analysis of intricate systems. Furthermore, interfacing MATLAB with Arduino hardware gives students the opportunity to work with high-level designs as they engage in system thinking [14], [21]. Including these resources within the curriculum supports Simulink and increases the efficiency at which students acquire relevant skills like problem solving to transition smoothly into the workforce [17]. For instance, most electrical engineering undergraduates' cursory program in MATLAB due to prior exposure, which leads to other, advanced concepts, such as robotics or embedded systems theory, later in the curriculum [4].



C. SPICE Simulation Software in Circuit Analysis

SPICE is especially important in the context of teaching electrical engineering as it aids in circuit analysis and simulation. Advanced circuitry does not require learning for physical components. SPICE enhances education by providing simulations, which improve understanding regarding internals of analog circuits.

Discussion of SPICE simulation software have been covered regarding particular topics dealing with reliability and availability in relation to electrical engineering, using it to teach principles that are difficult to grasp. Students learning from simulations gain additional practical understanding, which improves understanding from SPICE simulations [1].

D. Arduino and Single-Board Computers in Hands-On Learning

The integration of Arduino and other single-board computers (SBCs) has significantly transformed the pedagogical approaches towards electrical engineering by adding a practical dimension to it [28]. With the affordability and flexibility these devices offer, students are able to construct operative models, thereby surpassing the confines of merely learning concepts and applying them. The integration of Arduino with MATLAB and Simulink has also been researched for the purpose of data-driven algorithm creation and interaction [10].

Research has shown the impact of SBCs in enhancing students' motivation and engagement. For example, a systematic literature review was conducted on the use of SBCs in engineering education and documented the positive impact these tools had on curriculum redesign and overall learning. These tools foster experimentation and active learning, contributing to the enhancement of analytical and rational problem-solving capabilities aimed at professional challenges [5].

E. Challenges and Considerations in Integrating Computing Tools

Although the advantages of incorporating computing resources into the teaching of electrical engineering are clear, other issues require attention. As a result of modern computers, educators have to cope with a great deal of new knowledge, which in turn requires them to be professionally trained. Another important issue is the lack of equity in access to technological means, since such gaps often act as a barrier to fully benefitting from these resources. Additionally, there should be a careful consideration of the relationship between software skills and theoretical skills to avoid an overwhelming dependence on computational tools [22].

All these aspects rely on the proper construction of the course outline and its integrated support systems. For instance, the development of individualized educational systems that blend gamification with intelligent tutoring systems has been proposed to bolster educational effectiveness at the same time students' participation . Such measures could deal with specific learning challenges and nurture a more integrated educational framework [23].

F. Future directions and innovations

The technological advance poses new challenges for electrical engineering education Innovations in technology such as Artificial Intelligence (AI) and Machine Learning (ML) have the capability to optimize the outcomes of education systems through personalizing learning. The application of Virtual Reality (VR) and Augmented Reality (AR) allows participative learning enabling students to interact with the systems they are learning about within more sophisticated environments [27].

Innovative computing technologies still require adequate research to be fully functional and effective for the educational setting. Engineering educators are encouraged to broaden the scope of their teaching pedagogy and consider devising effective strategies corresponding with the unique challenges posed by the ever-evolving engineering world.

III. METHODOLOGY

This study incorporated a quantitative methodology to assess the level of awareness, usage, effectiveness, and difficulties encountered with computing tools in Pakistan's Electrical Engineering education. Students from a selection of public and private universities offering an Electrical Engineering were surveyed which led to a sample size of 400 respondents. This approach allowed for capturing the experiences and perceptions of students regarding computing tools in a manner that was quantitative and uniform across all respondents, making it possible to conduct statistical analysis.

The entire population of these students was given an online as well as an offline survey containing multiple-choice questions to capture the greatest sample possible. This included graduates and post-graduates, which were further broken down into BS/BSc, MS/MSc, and PhD levels. All these academic levels were stratified sampled so that all years of study could be represented.

The responses were interpreted and processed with SPSS Version 29. To analyze the demographic distribution and tool usage patterns, descriptive statistical methods like frequencies, percentages, and cross-tabulations were utilized. In order to improve clarity and interpretation, numerous visualization techniques such as bar and pie charts, radar graphs, and tabular summaries were used to display the results. This approach enabled the assessment of trends, patterns, and relationships among the variables, which is essential for formulating relevant discussions and conclusions regarding the integration of computing tools in teaching electrical engineering.

IV. RESULTS AND DISCUSSIONS

A. Demographic Information of the Respondents

The adjusted gender distribution data indicates that Male respondents still make up the majority at 280 individuals (70%), while Female participants have increased relative to previous counts, now totaling 120 individuals (30%).

The high percentage of male students in the sample is consistent with the underrepresented groups in the engineering workforce, including Electrical Engineering, whose global gender differences remain disparities worldwide. The still lower representation of female students, however, is noteworthy along with the 30% mark—it signifies the increasing inclusion and participation of women in engineering education and training, which is a welcome trend for gender diversity in the profession.

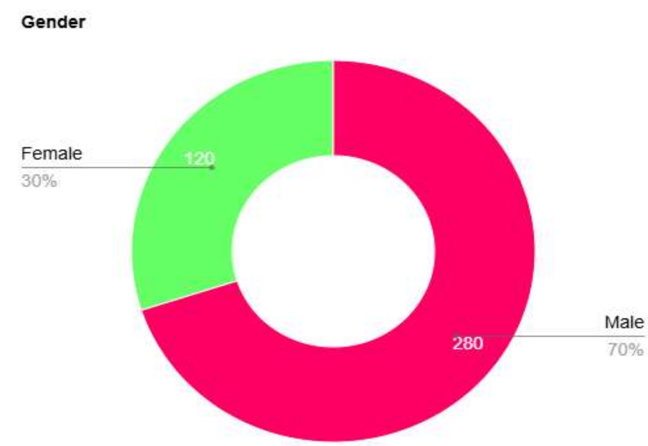


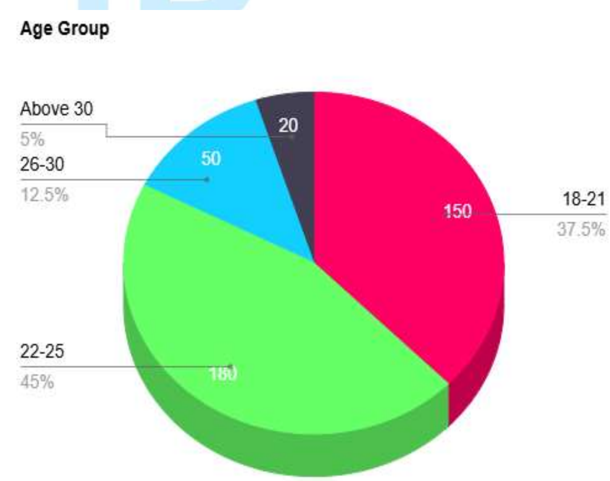
Figure 1. *Gender of the Respondents*

Despite gaps in male perspectives dominating the narratives, the data indicates some advances toward achieving balance in other survey responses governed by long-standing conventions. Therefore, any analysis interpreting the broader results of the survey must be grounded in this count—particularly as it pertains to discussions on the availability, level of interaction, or operational usefulness of learning materials and resources.

B. Age Group

The age distribution of the respondents indicates that the sample is relatively teenage and youthful, as it includes those in their late teens and early twenties. In this regard, the most frequently represented age bracket is 22 to 25 years which has 180 participants, thus constituting 45% of the overall sample. This implies that almost half of the respondents are within the early adulthood stage, which is usually characterized by high education level, entering job market, or experiencing various transitional phases of life.

The next largest group is made up of respondents aged between 18 and 21 years, which adds up to 150 participants, or 37.5%. These two age



cohorts (18 to 25 years) taken together account for 82.5% of the total sample, confirming that there were many younger respondents.

In comparison, the older age categories are represented to a much lesser extent. Only 50 respondents (12.5%) fall within the age bracket of 26 – 30 years and only 20 respondents (5%) are above 30 years. This steep drop in participation from the older age groups suggests that the survey is mainly capturing the views of a younger population, which could affect the relevance and usefulness of the findings to older populations.

Broadly speaking, the data illustrates a predominantly younger age group, which may be expected based on the context of the survey, like one conducted among students or young professionals. However, the scant representation of older age groups should be taken into account when extrapolating results outside this age range.

C. University Type of Respondents

Public universities clearly dominate the data selection, as the sample consists of 300 participants from public universities, amounting to 75 percent of the sample. The number of respondents from private universities is significantly lower, with only 100 respondents (25%). It can be confirmed therefore, that the survey responses were predominantly solicited from individuals affiliated with public universities.

The overwhelming majority of public university students who took part in the survey may reflect the patterns of student enrollment in that region, or it could be the result of purposeful sampling directed at public universities. P There is greater diversity in the student population at public universities as compared to their private counterparts. This is likely a reflection of the increased accessibility and affordability of public institutions.

Tomms, this conclusion impression is not only correct, but misses the mark regarding private university students who do not at all represent. This is particularly notable if, the research focuses on institutional components alongside factors like, resources, or academic structure of the private institution.

The tuition, according to the study, is a hypothesized area worthy of argument within the scope of focus. Overall, the university type distribution shows an imbalance towards the enrollment of students from public universities, which poses potential risks projection intended.

It stands to reason considering these factors along with the survey findings, which are not masked by preconceptions.

TABLE 1
UNIVERSITY TYPE

University Type	Frequency	Percentage
Public	300	75%
Private	100	25%

D. Degree Program of the Respondents

Most students focus on undergraduate studies in Electrical Engineering and this is evident by viewing the data from respondents by their degree specialization. Participants 250, for instance, 62.5% of them claim they are pursuing a BS/BSc in Electrical Engineering which suggests that the majority of the data amassed is from undergraduate students is because of the perception and experience is of undergraduate students.

The next largest group is composed of 120 respondents (30%) claiming that they are pursuing an MS/MSc degree in Electrical Engineering. This represents a sizable minority that undertakes the study with those having a slightly advanced academic background, who presumable also sufficed some needs of the constructs and the frameworks being investigated, in other words, this group is younger, however, not pregnant in other words, not as underage as the undergrads.

A relatively small number of respondents on the doctoral level, just 30 participants (7.5%) enrolled in a PhD program. This small number is likely indicates much lower enrolment in PhD programs or the presence of those willing to actually make available to participate.

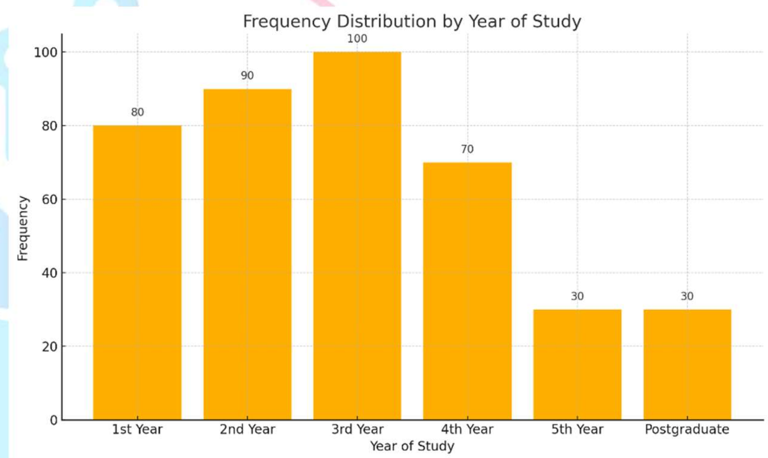
These data support the fact that there is immense proportion of respondents at the under-graduates; however, there is lesser and lesser amount of respondents as one moves up the academic hierarchy. This situation has to be taken into consideration as the primary focus of the research was to look for the answers to questions which were aimed at analyzing the professional or technical outcomes because the answers based on these aspects are bound to be mostly reflective of the sophisticated experience, with elementary responses for more advanced levels.

TABLE 2
EDUCATIONAL LEVEL

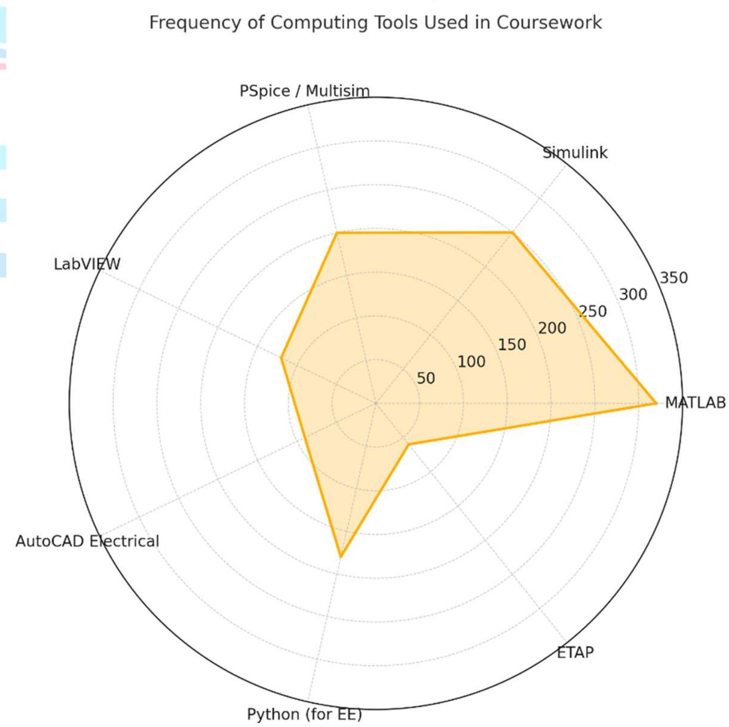
Degree Program	Frequency	Percentage
BS/BSc Electrical Eng.	250	62.5%
MS/MSc Electrical Eng.	120	30%
PhD Electrical Eng.	30	7.5%

E. Year of Study of the Respondents

The respondent distribution by year sheds additional light on the academic level of respondents within their respective degree programs. The data suggests that respondents are concentrated in the middle years of their studies. The 3rd year students are the largest block with 100 participants (25%) followed by 2nd year students with 90 respondents (22.5%). Together, these two groups constitute 47.5% of the sample, which indicates a concentration of respondents likely in the transition phase from the basic courses to more advanced ones.



First year students constitute 20% of the sample which indicates that these respondents are novices to the program and shows a good representation of lower-level students. Fourth year students represent 17.5%, and third year students make up a smaller portion at 7.5%; likely correlating to longer programs such as engineering degrees which include internship or project components during the latter years.



In addition, other postgraduate students (encompassing both Master's and PhD levels) also constitute 7.5% of respondents. This corroborates the previous findings on the degree programs confirming the limited but existing presence of students post undergraduate level.

Together with the rest of the findings, this data points towards a sample that is largely comprised of undergraduate students, particularly in their 2nd and 3rd years of study. This suggests that the feedback received is likely from students who have gained some academic experience but are not yet at the very end of their studies. Such distribution gives a balanced representation of early to mid-stage students alongside a slight representation of the final year and postgraduate students.

F. Awareness & Usage of Computing Tools

Which computing tools have you used in your coursework? *(Multiple selections allowed)*

Surveys centered around tools for computing driven by Electrical Engineering students indicate that they are well acquainted with commercial engineering and simulation tools, especially those that are integral and form the basis for coursework along with lab activities.

Without a doubt, MATLAB is the most widely used tool. 320 respondents (80%) reported using it. This percentage is indicative of the use of MATLAB in engineering education, especially in undertakings like numerical computing, signal processing, and system representation. Also, a considerable number of students, 250 (62.5%), reported using Simulink which is the model based design extension of MATLAB. This indicates that much of the learning in the teaching is through simulations.

The use of PSpice / Multisim, widely recognized for their capabilities in circuit simulation and analysis, is noted among 200 students (50%), which underscores their relevance for teaching circuits and electronics design. The fact that half the respondents have used these tools indicates that they are reasonably well integrated into the curriculum, although not as commonly used as MATLAB or Simulink.

TABLE 3
SOFTWARE TOOLS

Tool	Frequency	Percentage
MATLAB	320	80%
Simulink	250	62.5%
PSpice / Multisim	200	50%
LabVIEW	120	30%
AutoCAD Electrical	90	22.5%
Python (for EE)	180	45%
ETAP	60	15%

Based on the data analyzed, Python has the highest number of respondents at 180 (45%). This is impressive, given that Python is a general-purpose programming language with increasing use in engineering fields, particularly in data analytics, machine learning, and automation. This trend is indicative of a more contemporary and adaptable approach being adopted in programming pedagogy aimed at Electrical Engineering students.

LabVIEW, a graphical programming environment for controlling instruments and data acquisition, was mentioned by 120 students (30%). Students are more likely to use MATLAB or Simulink, but LabVIEW's popularity suggests that a reasonable proportion of students are engaged with practical activities related to control systems.

AutoCAD Electrical for electrical design and documentation was used by 90 respondents 90 (22.5%). This suggests that AutoCAD is taught and used in design oriented courses or electives, but not to the extent that would be expected. Lastly, only 60 students (15%) reported usage of ETAP, a program designed for specialized power system analysis and electrical safety. This percentage is lower than others are because ETAP is most applicable at later stages of study in or power systems specialization tracks, where more industry relevant projects are integrated.

As stated earlier, the data collection indicates that MATLAB and Simulink remain fundamental resources within EE education, whilst other niche resources such as Python, PSpice, and LabVIEW are increasingly becoming popular. The observed usage patterns are indicative of the curriculum framework and specific refinements in engineering software alongside both simulation and coding workflows toward emerging tools.

G. How often do you use these tools?

The statistics on the frequency with which students apply computing tools indicates a strong pattern of frequent engagement use. The largest group of respondents, 150 students (37.5%), reported using computing tools during the week. This implies that for many, these tools are integral to coursework and assignments, presumably embedded within laboratory activities or project work.

A good number of, 100 students (25%), use the tools on a daily basis, which is quite indicative of frequent engagement. These students may be undertaking advanced design projects, research activities, or even final year tasks which involve repetitive simulation and extensive analysis. Daily usage indicates that these individuals have a plethora of computing tools at their disposal and rely on these extensively for solving issues.

A further 80 respondents (20%) claim they use these tools on a monthly basis. This set of users had ess active than daily or weekly users, still constitutes a moderate degree of knowledge related to the tools. This usage profile may indicate either the design of some curricula that involves infrequent tool-based assignments or the time of the academic year (e.g., early semester phases or courses with a lot of theoretical content).

Few students reported that they rarely use the tools (50 respondents or 12.5%) and a further 20 (5%) reported that they never use them at all. These respondents might be in earlier years of study, have limited exposure due to their selected courses, or are existing in programs with a minor focus on practical computing skills.

As noted, 82.5% of students compute monthly make use of computing tools, especially with a focus on weekly and daily use, underscoring their relevance in contemporary Electrical Engineering education. This distribution confirms the hypothesis that mastery of computational skills enhances the education and professional training offered to students in this field.

TABLE 4
FREQUENCY OF USAGE

Frequency	Frequency	Percentage
Daily	100	25%
Weekly	150	37.5%
Monthly	80	20%
Rarely	50	12.5%
Never	20	5%

H. How did you learn these tools? (Multiple selections allowed)

The information provided regarding gaining proficiency of computing tools during education in an Electrical Engineering shows an elaborate learning ecosystem that inculcates formal teaching, self-teaching, and group work.

A greater proportion, 300 respondents (75%), stated that university courses were the primary technique of learning; thus, it is the most common method of learning. This indicates the great pedagogical impact on the development of technical skills and the integration of software tools into the curriculum. That three quarters of students learned through formal coursework illustrates that computing tools are integrated into academic programs and considered functional basic resources engineering education software is a pedagogical necessity. In addition to formal lectures, 200 students (50%) completed online tutorials, indicating the growing value of easy-to-access, self-paced educational resources like YouTube and Coursera. This indicates that albeit foundational knowledge is acquired through formal education, a significant number of students enrich the content provided by educational institutions with external digital resources to enhance or explore concepts at their own pace.

The mention of self-learning by 150 (37.5%) indicates a reasonable degree of self-initiative among the students. These learners likely approach the tools through most probably personal projects or interest-driven study and thus further strengthening required in the engineering field versatility and evolving skill set.

The influence of collaboration was noted by 120 students, which is 30% of the population, suggesting that peers learning from one another also had an impact. This is characteristic of social learning in the technical

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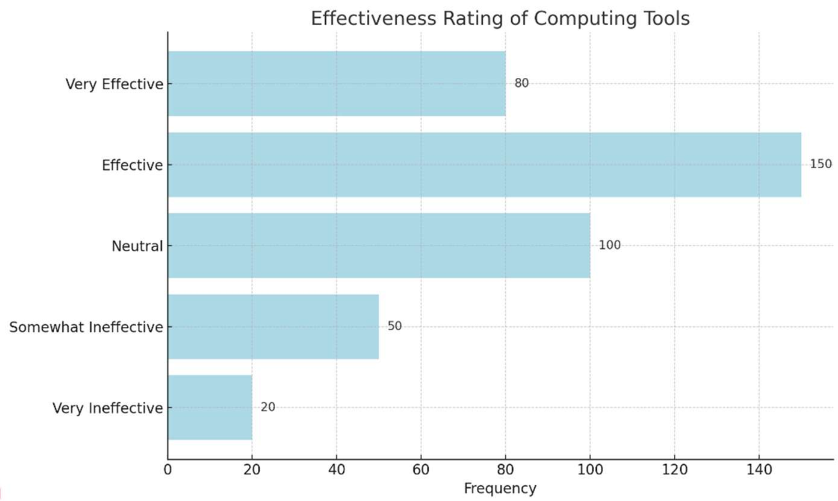
field, where informal interaction through knowledge exchange, group work, or study groups greatly improves the application of methods and tools in practice.

Participation in workshops was reported by 80 students (20%) which suggests that some students volunteer or attend industry-sponsored workshops designed to help learners acquire new skills. Workshops, though less prevalent, are known to give learners the opportunity to apply what they have learned in a practical setting in contrast to classroom learning.



Thus, teaching through university-led instruction is the primary method of learning computing tools for students. However, a noteworthy proportion of students augment their learning through other resources such as the internet, interactions with peers, and independent initiative. Such a blend of learning methods captures the essence of structured education intertwined with the agility and initiative of learners to foster growth.

TABLE 5
LEARNING METHOD

Learning Method	Frequency	Percentage
University courses	300	75%
Online tutorials	200	50%
Self-learning	150	37.5%
Workshops	80	20%
Peers	120	30%

SECTION 3
EFFECTIVENESS & CHALLENGES

A. How effective are these tools for learning?

Like many other surveys on the use of computing tools and their usefulness in learning Electrical Engineering concepts, the sentiments recorded from responses is largely positive albeit with mixed opinions capturing the many strengths and issues that could be worked on.

Out of the total sample size, 150 respondents (37.5%) rated the tools as “Effective”, which means a considerable portion of students are able to appreciate and value these tools and its usefulness in education. This group likely benefits from enhanced Understanding through simulations, modeling, and real world applications made possible by these tools. Also, 80 students (20%) rated the tool as “Very Effective” which increases the total positive responses to 57.5%. With this, it can be interpreted that more than 50% of respondents actually feel that the use of these tools facilitates learning and adds educational value, which is a notable achievement.

On the contrary, 50 respondents (12.5%) rated the tools as “Somewhat Ineffective” and 20 students (5%) rated them “Very Ineffective”. Even though these negative ratings are small comparatively, the assumption can be made that some students lack familiarity with the tool, proper training, or integration of the tools with their course work. If so, then the use of these tools may serve to impede learning.

Remarkably, 100 students (25%) displayed an indeterminate disposition, demonstrating neither great endorsement nor active discontent. Such neutrality is likely attributed to lack of interest, limited exposure, or the understanding that while useful, computing tools are not essential to their learning processes.

To summarize, the information seems to indicate that computing tools are viewed in a positive manner regarding their effectiveness during the learning process, suggesting that more than half of the students see value in their education. Nonetheless, a balance of indifferent and adverse responses highlights that there is still some level of disconnect pertaining to integration, support, and perhaps greater ease of use that needs addressing in order to fully optimize outcomes for all students.

A. What challenges do you face? (Multiple selections allowed)

The information collected points out the different serious problems Electrical Engineering students encounter while dealing with computing tools, most of which can potentially influence their learning as well as engagement levels. The lack of training is the most reported hurdle and was noted by 250 respondents or 62.5% of the participants. Given the previous finding that implies university courses are the predominant source of learning, this suggests some lack of on-the-job training. It may also suggest some degree of training that instructors expect students to achieve is exceedingly intricate, leading to myriad nuances interacting with a well-defined system without collaborative assistance, or limited direction.

The survey also revealed that 200 respondents, or 50%, noted high software cost as a challenge. This represents the amount of money that students need to pay to access licensed engineering software such as MATLAB, ETAP, or AutoCAD. This is especially troublesome in situations where students are presumed to work on their personal devices away from university labs, posing financial limitations to practicing often.

Another issue stems from complexity of software as identified by 180 students (45%). Many engineering tools are accompanied with aggressive software advertisement describing their functions which culminate in years of unremitting hours spent on course to achieve mastery. This overwhelming challenge often breaks students in their initial years of study, further compounded by inadequate surrounding help structures.

Slow computers were a reported issue for 150 respondents (37.5%) which suggests the inability to run heavy software efficiently due to the hardware constraints. This technical issue can cause significant frustration, time wastage, and even demotivation, especially for computing-intensive tasks like simulations or large model runs. Internet-related problems that were reported by 100 students (25%) could impact users with cloud-dependent tools, online resources, or software that is constantly needing to be updated or activated through the internet. This is especially important for students living in remote locations or those with unstable connections.

As a whole, the issues mentioned—most prominently, lack of training, high software costs, and intricate software hierarchies—show that computing tools, while perceived as useful for learning, have several structural and technical obstacles to their effective use. These issues such as enhanced instructions, improved resource allocation, and better infrastructural resources could fundamentally transform the effectiveness of tool-aided learning in Electrical Engineering programs.

TABLE 6
CHALLENGES

Challenge	Frequency	Percentage
Lack of training	250	62.5%
High software cost	200	50%
Slow computers	150	37.5%
Internet issues	100	25%
Software complexity	180	45%

B. Which tool is most useful?

When asked to identify the most useful computing tool in their coursework, 180 students, or 45%, selected MATLAB as the computing tool that had the most value to their coursework, which illustrates that the students were in consensus about the computing tool that had value for them. This affirms the earlier data that also suggested that MATLAB is the tool that is most commonly used, having an 80% usage rate, and corroborates the important position that MATLAB holds in the education of Electrical Engineering. MATLAB's perceived usefulness stems from its flexible nature and stringent mathematical modeling requirements, signal processing, control, data analysis, and a myriad of other fields in broadcasting.

Simulink follows as the second most useful tool, with 120 students (30%) selecting it. In addition, Simulink provides an easy-to-use, graphical environment that integrates seamlessly with MATLAB. Because of these simulative extensions, it greatly aids students in the development and evaluation of dynamic systems, which makes it even more valuable for students focusing on control systems, power electronics, and embedded systems.

Selected by 60 respondents or 15%, PSpice / Multisim are in third place in the ranking. While not as broadly applicable or useful as MATLAB and Simulink, these tools are essential for students focusing on circuit design, because they are primarily used for the simulation and analysis of circuits, which form the basis of analog and digital electronics courses.

With its role in instrumentation and data acquisition, LabVIEW is chosen by 10% of respondents or 40 students. It is likely best suited for laboratory environments where actual hardware manipulation is required.

To conclude, the information provided distinctly demonstrates that students consider MATLAB and Simulink to be the most useful parts of the coursework due to the tools' versatility and further relevance throughout the Electrical Engineering program. Although PSpice and LabVIEW also seem to be valued, their appreciation comes across as somewhat specialized or situational. This understanding is useful for informing educators on the relevant priorities that focus on the students' specialized tool training and align with curriculum demands.

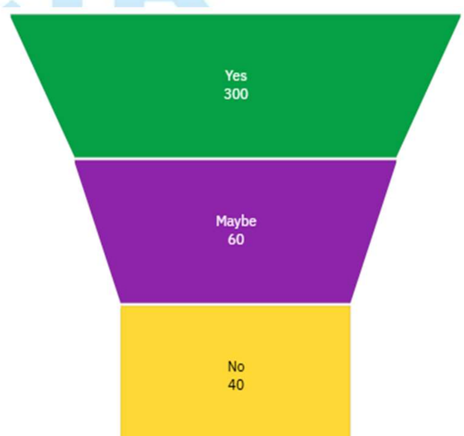
TABLE 6
USAGE OF TOOL

Tool	Frequency	Percentage
MATLAB	180	45%
Simulink	120	30%
PSpice / Multisim	60	15%
LabVIEW	40	10%

SECTION 4
SUGGESTIONS & IMPROVEMENTS

A. Should universities provide more training?

The decisive proportion of respondents pointed out that universities ought to strengthen their services in the area of computing training. Three hundred students – 75% – answered "Yes" which indicates that there is strong support for more organized, thorough, and possibly practical training. This is consistent with earlier findings that 62.5% of students mentioned lack of training as one of the predominant issues, which reinforces the notion that current instruction does not overload information enough, is not easy to get, or does not happen often enough.



A smaller section comprising of 60 respondents, or 15%, answered with “Maybe.” This suggests relative ambiguity on the issue. They may think that there is a difference based on individual learning style, year of study, or specific tool being employed. They may see the current training as adequate but not comprehensive, which suggests that there is an overriding need for different approaches to instruction.

Perhaps the least number of participants, 40 or 10%, answered with “No.” This indicates that a few feel that the available training is adequate for their needs because of having benefited from proper training, or having their own instructional preferences where they teach themselves.

In summary, the data shows that most students are in favor of universities putting more focus on training sessions regarding the use of computing tools at an advanced level. Hence, the institutions should seriously consider the need for practical workshops, incorporating tools into the course outlines at a higher level, and providing more support materials so that the students are able to use the tools more effectively.

B. Which tools should be added to the curriculum? (Multiple selections allowed)

When students were asked what additional tools ought to be added to the syllabus of the Electrical Engineering discipline, they showed great insight by highlighting the current industry technologies, which surpass the traditional engineering software used in teaching.

The recurrent suggestion was that of the inclusion of Advanced Python with specialization in AI/ML for 220 respondents (55%). This shows increasing recognition of data science and intelligent systems’ importance in engineering disciplines. With regard to postgraduate education and employment, there is a desire to obtain relevant skills. Students are readily willing to utilize Python beyond the basics to include advanced functions predictive modeling, automation, and smart systems.

180 students (45%) suggested PLC (Programmable Logic Controller) Programming Tools, reflecting a considerable level of interest in automation and industrial control systems. PLCs are common in the manufacturing and process industries, and knowledge of such tools can enhance students’ employability. This also suggests that the students want to learn engineering concepts from a practical perspective as opposed to purely theoretical.

As a simulation system for Power Systems and electromagnetic analyses, ANSYS was recommended by 150 students (37.5%) which further indicates ‘their focus on power electronics, system reliability, or high-voltage applications’. Its mention indicates interest in more advanced simulation capabilities, especially for students focusing on power electronics, system reliability, or high-voltage applications.

The students who selected Cloud-based Electrical Engineering tools along with collaboration tools and online simulation software totaled 100 respondents (25%). This indicates increasing value being placed on remote access and flexibility along with collaborative learning environments as well as in a post-pandemic educational setting where the accessibility of digital resources is important.

Overall, the students with suggestions on the instructional material offered make it clear that modern and contemporary tools from industry recognized software and applications into the curriculum would be beneficial. The changes in focus to Python for AI/ML, industrial automation with PLC-controlled systems, enhanced simulation and modeling with ANSYS, cloud-based services, and other solutions point towards students wanting an advanced and more interdisciplinary core engineering education.

V. LIMITATION OF THE STUDY

This research implemented a quantitative methodology which effective in discerning trends and establishing connections between variables, may overlook the depth of personal experiences and insights that students provide contextually. The sample is disproportionally biased towards male (70%) and undergraduate students which affects representativeness. With prior research focusing on public university students (75%), there is a lack of generalizability for private institutions. There is also a possible response bias with the self-reported data provided.

VI. CONCLUSION

This study concludes that computing tools are playing a transformative role in the learning and teaching of Electrical Engineering across universities in Pakistan. Based on the quantitative approach of surveying 400 randomly selected students, it was clear that tools such as MATLAB, Simulink, Python, and PSpice are staples in the academic life of engineering students. The results show that more than 80% of students who have access to MATLAB and Simulink consider these tools to be highly useful and are in fact using them, which is positive. In addition, more than fifty percent of the respondents consider these tools to be useful or very useful in improving their understanding and level of skills in the concepts taught.

The study also revealed some very important barriers that stand in the way of maximizing the benefits offered by these tools. Some of the hardest issues reported included lack of adequate training, high costs of purchasing the software, complex nature of the software, and insufficient computing facilities. Although university courses were the main avenues of learning, a lot of students also reported learning through independent online tutorials, self-teaching, and through discussion with peers—indicating that there is a gap between what is offered by institutions and what is required by learners. These constraints point to the fact that there is insufficient attention given to the pedagogical integration of these tools into curricula at both primary and secondary levels.

VII. RECOMMENDATIONS

Universities need to refine the scope and quality of the computing tool training offered by adding workshops that are more practical, structured lab sessions, and tool-specific courses. In addition, there is a strong case for integration of advanced programming modules: Python with AI/ML and PLC software, ANSYS, and cloud-based simulation platforms.

Furthermore, integrating proprietary software into the institution at a subsidized cost could resolve some financial and technical constraints posed to the institutions' clients. In addition, upgrading lab facilities to support heavy simulations could ease some technical constraints.

To ensure technological and industrial relevance of educational content, students should be allowed to provide feedback actively. Such changes would make learning environments more practical, inclusive, and responsive to electrical engineering students' future needs.

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