

# How Effective Are AI Tools for Diverse Learners? A Case Study on Python and Data Science Education

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## Abstract

Artificial Intelligence (AI) based tools (such as ChatGPT) has revolutionized the learning methodologies for complex subjects by introducing the innovative methods in education. This study focuses on how AI tools can be helpful for the undergraduate students at Shah Abdul Latif University in learning the Python programming and Data science concepts. The study was conducted on beginners and intermediate groups of students through an organized survey by comparing their experiences gained through interactive tasks. The survey results reflect that intermediate users get more benefits from AI tools due to their familiarity with the technologies, whereas beginners face challenges in comprehension and ease of use. The study concludes recommending some practical suggestions to enable AI tools more effective, comprehensive and user-friendly.

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## 1 Introduction

Imparting education is passing through changes rapidly with the popularity of Artificial Intelligence (AI) tools. Simplifying responding the complicated queries and resolving problems quickly have become possible with the help of tools like chatGPT. This phenomenon deemed fit with Education 4.0, which is about using emerging technologies such as AI and VR to make learning more personalized. Instead of memorizing facts, students engage in interactive and hands-on experiences that build real-world skills. This approach helps them in critical-thinking and they can adapt to the fast-changing job market [1]. AI tools are helpful as they can be adapted as per students' requirements. For example, ChatGPT can split complex tasks in small easily achievable subtasks and can describe the subtasks without ambiguity. It is evident that AI tools can provide an interesting learning environment especially for complex subjects [2]. AI tools are beneficial but they are not flawless. Beginners are sometimes not comfortable using the tools as they do not know how to ask questions correctly. However students who are



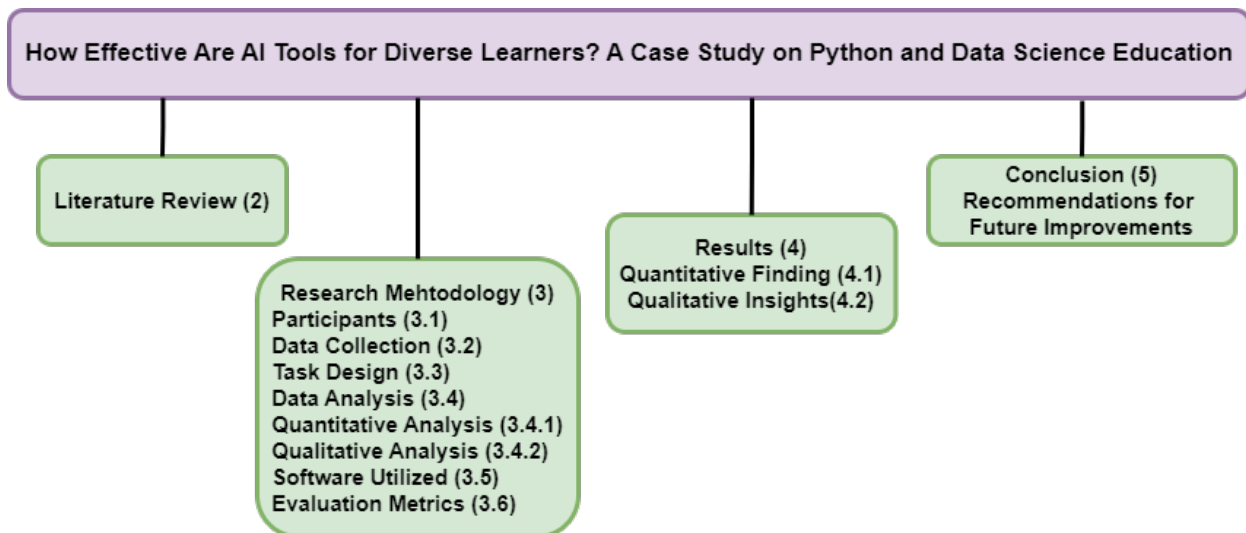
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more familiar with using the tools expect detailed and precise responses. These challenges demand design of AI tools to be fine-tuned. Students who learn programming and data science have different depths of knowledge. AI tools need to accommodate varying levels of students, keeping the tradeoff between ease of use and breadth of the comprehension and designers must sustain, some contradictory, requirements [3].

ChatGPT modifies the teaching methodologies by changing conventional role of teachers to enable them as facilitator for personalized learning, adopting inquiry based skills and considering ethical aspects, which may result in more versatile and effective learning environment [4]. The study stresses that to address the cultural challenges in education; transformative changings are indispensable, especially in the context of digital age and Covid-19 disruptions. It highlights that adopting emerging technologies is not sufficient instead, a major shift in learning approaches is required which undertakes creativity, collaboration and critical thinking [5]. Based on the findings from this research [6], the educators will be able to use ChatGPT efficiently. A comprehensive learning environment can be developed, by refining these tools, for the students of the digital era who can gain better using them and learning the complex subjects such as programming and data science will not be so challenging.

The remainder of the paper is organized as follows: Section 2 describes Literature Review. Section 3 discusses Research Methodology. Section 4 presents the Results and finally section 5 concludes along with recommendations for future improvements. The hierarchical structure of the paper is depicted in Figure 1.

This study examines how ChatGPT can assist the undergraduate level students in learning programming and data science concepts in terms of ease-of-use, how long it takes to complete the task and if the users are satisfied with results. The focus of this study is on highlighting the best user-friendly features of ChatGPT and to underline the aspects where user-centric improvements are required.



**Figure 1.** The hierarchical structure of the paper

## 2 Literature Review

Various cutting-edge studies have been conducted to analyze the effectiveness of AI and Large Language Models (LLMs) for diverse learners. In order to deliver a broad analysis of adaptive learning impact on education outcomes, the study uses both quantitative and qualitative research methods. Qualitative data is gathered through observational techniques such as survey while quantitative data is collected by means of assessments, surveys and system analytics. The research includes a well-structured experiment to track how students improve by comparing their performance before and after assessments. A deeper insight regarding user experience and system

effectiveness is provided by this two-fold approach. Statistical methods are incorporated to analyze the data for robust and reliable results. For example, assessment scores can be compared to scale the effectiveness of adaptive learning systems [7]. The methodology takes into consideration the important multimedia learning principles such as redundancy, coherence, and signaling to organize the content in the way that the brain perceives information [8]. The ideas of the Cognitive Theory of Multimedia Learning (CTML) were utilized to create learning materials, which improve the engagement and learning efficiency of the students [9].

The study [10], examined how AI influences education by analyzing data from 500 students. To compare different learning approaches, the students were split into two groups: 250 followed a traditional learning method, while the other 250 experienced an AI-driven, personalized learning environment. The key performance indicators: assignment scores, test results and overall grade points per semester were calculated which offered clear comparisons of the student performance between mentioned groups. In this research diverse research methodologies such as PageRank, machine learning and rule-based techniques were included to highlight the importance of AI in addressing complex problems and to develop a robust model for decision-making practices, more sophisticated techniques were used. These techniques included simulated evolution, swarm intelligence, natural language processing and symbolic regression [11] [12], moreover the significance of clear project definition and iterative refinement is emphasized by structured overflows [13]. The relationship between variables in usability evaluations are assessed by statistical methods such as Pearson's correlation coefficient and Chi-Square goodness of fit test [14] [15].

The research was conducted in multiple stages, aiming on different aspects of students' interaction with Chat-GPT. The main step comprised introducing students to the tool and allowing them explores its functionalities independently. This was targeted at encouraging engagement and autonomy in learning AI applications in software development [16]. The study explicitly targeted first-year students who were enrolled in computer science and software courses. This effort was intentional to highlight the significance of findings associated to demographic, although it restricted the generalizability of the results to a broader student population.

The review focused on studies published from January 2007 to October 2023. This time interval was chosen because research on AI applications in higher education began to considerably grow around 2007. The methodology of this research is categorized by a systematic review process, careful coding, and a focus on empirical studies. It collectively contributes to understanding the role of AI in blended learning environments. The systematic review disclosed that AI applications were largely used for the online asynchronous constituent of blended learning, with limited research on role of AI in connecting online and offline activities [17].

A PLS-SEM-ANN approach employs a two-stage methodology that joins two advanced analytical techniques: Partial Least Squares Structural Equation Modeling (PLS-SEM) and Artificial Neural Networks (ANN). The study focuses on the quantitative research method by collecting the numerical data from students who use AI tools with the help of survey. The statistical analysis of the variables concerning students' satisfaction was tackled by this approach. The combination of PLS-SEM and ANN offers a robust framework for the analysis. PLS-SEM is used for hypothesis testing, while ANN is utilized for calculating the causal effects besides the significance of known factor. This two-stage approach enhances the reliability and validity of the findings [18].

The research on the roles as well as on trends of artificial intelligence (AI) in higher education utilized a variety of policies and algorithms. The most frequently adopted algorithm was knowledge elicitation methods via interviewing domain experts (40% of studies), followed by mixed algorithms (30%), Bayesian inference and networks (10%), traditional machine learning approaches (10%), deep learning or neural networks (8%), and case-based reasoning (2%) [19].

The primary methodology used in this research [20] is cost-benefit analysis, which calculates the economic implications of regulatory resolutions. This methodology helps in understanding how the costs and benefits of

legal enforcement affect the performance of different entities which are involved in AI administration, such as government bodies, third-party institutions, and AI companies.

### 3 Research Methodology

Our research used quantitative as well as qualitative methods for evaluating, how much AI tools such as ChatGPT are effective in learning atmosphere especially for programming and data science. This dual-method approach provided a comprehensive perspective on user experiences and ensured the analysis as reliable.

#### 3.1 Participants

The participants in the study were 300 undergraduate, computer science students, who were chosen using convenience. The sample group was in the age of 17 to 19 years. All the participants were registered at the Shah Abdul Latif University and a group of two equal sizes was formed of the participants.

**Beginners (150 participants):** Students that have never experienced the use of AI tools before.

**Intermediate users (150 participants):** Students that are familiar with AI tools and have some prior exposure.

A fairly balanced group of students was created by splitting them into two parts, which facilitated a comparison and provided the accurate information about the impact of AI on the learning outcomes.

#### 3.2 Data Collection

The research was a synthesis of quantitative information and personal response to have a comprehensive perspective of the results.

**Quantitative Data:** The respondents were requested to give their perception regarding 5-Likert scale: how easy the process was to follow, the clarity and understandability of instructions, time taken to complete the task, whether the task achieved its objectives, and their satisfaction levels. They gave feedback on a basic 5-point rating scale, with an option of strongly disagree, strongly agree, in order to reflect the experiences as accurately as possible.

**Qualitative Data:** Open-ended questions enabled students to tell about their difficulties, impressions, and suggestions of how AI-assisted learning might be improved.

#### 3.3 Task Design

Design In order to measure ChatGPT utility, four tasks were allocated:

**1.Understanding Python Variables:** The Students studied the explanations as provided by ChatGPT on simple concept of programming.

**2.Programming Task:** The Participants experimented with ChatGPT on how the program could be used to create a simple program that helps to compute the average of a list of numbers.

**3.Data Visualization:** Practice the data visualization through the assistance of ChatGPT using the Matplotlib library.

**4.Advanced Data Science Concepts:** Advanced concepts, such as linear regression, data normalization, were learned with the assistance of responses, which were proposed by ChatGPT.

To conduct the study, the research was conducted in a number of steps in order to be precise:

**1.Introduction to tool:** The students got introduced to the ChatGPT and requested to research the features of ChatGPT on their own.

**2.Task Completion:** The participants were allowed to complete the tasks assigned to them and rate them basing on their experience.

**3.Feedback Collection:** Open-ended feedback was requested to gather personal opinions and suggestions.

### 3.4 Data Analysis

The data obtained was processed with the help of several statistical and thematic methods to obtain sensible conclusions:

#### 3.4.1 Quantitative Analysis:

The most important metrics were determined with the help of statistical measurements, such as:

**Descriptive Statistics:** Means and the standard deviations of the scores offered an overview of overall performance.

**Inferential Statistics:** T-tests and p-values were calculated to identify significant differences between beginner and intermediate groups. Effect sizes were also measured using Cohen's d to assess the practical meaning of findings.

#### 3.4.2 Qualitative Analysis:

Answers to open-ended questions were summarized into shared themes to draw attention to the lingering problems, recommendations, and user feedback.

The research was based on strong instruments and principles in order to achieve accuracy:

### 3.5 Software Utilized:

Statistical calculations were computed using SPSS and efficient data collection was done using SurveyMonkey.

### 3.6 Evaluation Metrics:

The experience of students was evaluated based on usability, clarity, time efficiency, relevance of tasks and satisfaction in general.

The Participants were made aware of the purpose of the study and they were guaranteed of their freedom to pull out at any point. Data collection was done in a confidential and ethical manner that gave a guarantee of voluntary and informed participation.

## 4 Results

The quantitative and qualitative findings are presented below:

### 4.1 Quantitative Findings

The intermediate users scored more consistently higher on all the metrics which explains the fact that they were more familiar with AI tools. Statistical analysis showed that there were significant differences in understandability, effectiveness and satisfaction, meanwhile, ease of use and time efficiency were moderately different. The t-tests as well as effect size measures (Cohen d) were used to confirm these results which support the high level of analytical accuracy. Figure 2 presents the principal quantitative measures comparisons in the two groups.

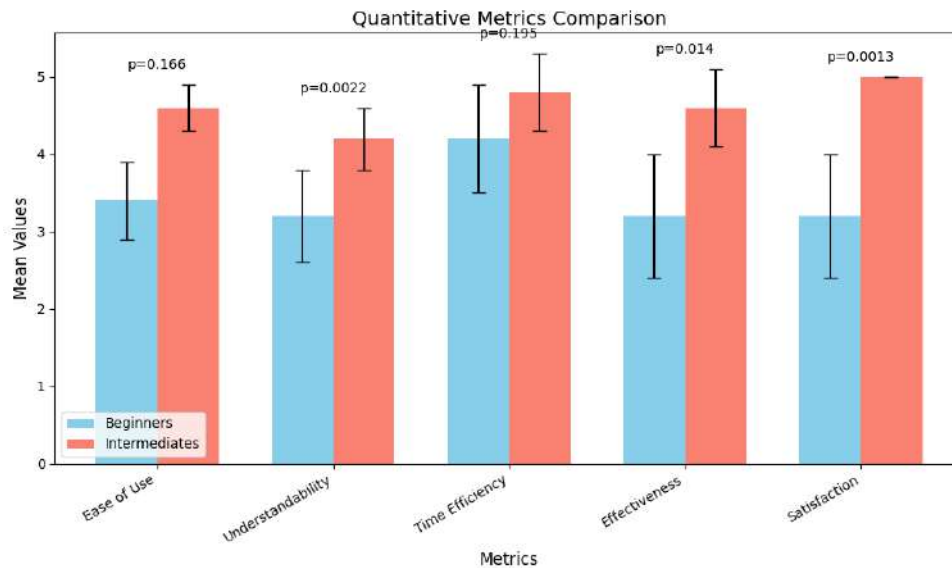
**Ease of Use:** The beginners rated it to be 3.4 indicating moderate difficulty, but the intermediates rated it was 4.6 indicating high accessibility. The difference is justified with the help of a t-test ( $p = 0.166$ ) and a moderate effect size ( $- 0.96$ ).

**Understandability:** They scored 3.2 meanwhile intermediates had a score of 4.2. A significant gap was proved by the t-test (0.0022) and the large effect size ( $- 2.8$ ).

**Time Efficiency:** The time that intermediates used to complete tasks was faster (mean = 4.8) than beginners (mean = 4.2). It is not a statistically significant effect ( $p = 0.195$ ), but the effect size ( $- 0.89$ ) is rather significant which indicates that there are significant differences.

**Effectiveness:** Intermediate users scored 4.6, significantly higher than beginners at 3.2 ( $p = 0.014$ ), and large effect size ( $- 1.98$ ).

**Satisfaction:** This metric showed the widest disparity, with intermediates rating satisfaction at a perfect 5.0, compared to 3.2 from beginners. The t-test ( $p = 0.0013$ ) and large effect size ( $- 3.04$ ) highlight this finding.



**Figure 2.** Comparison of Beginners and Intermediate user ratings of five key metrics

## 4.2 Qualitative Insights

**Challenges for Beginners:** Beginners had trouble with formulating prompts and grasping complicated explanations, mostly during working on more challenging topics such as linear regression. They advised that visual aids and step-by-step tutorials should be added to make it more accessible and understandable.

**Strengths for Intermediate Users:** To intermediate users, the efficiency of tool and accuracy was liked, with them stating that its short response was remarkably real. They suggested more complex features, including custom study plans and better contextual awareness to make the use of the products even more comfortable.

**Insights from Study:** The analysis of the computations indicated some paramount areas of dissimilarity across groups. As a case in point, the  $d$  calculations by Cohen showed serious practical variations in such measures as effectiveness and satisfaction. In addition to this, trends in user reaction showed that adaptive algorithms had the capability of reducing challenges experienced by novices.

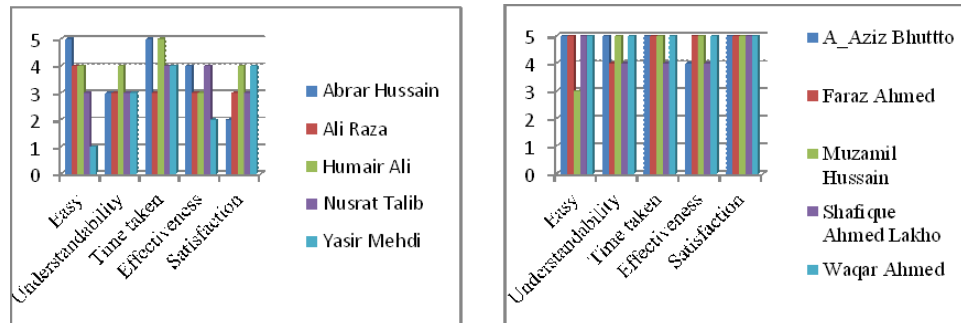
**Analysis-1:** The intermediate users gave the AI tool a higher rating on all measures, especially those of understandability, effectiveness, and satisfaction, because they were already familiar with such tools. Novices had more difficulties, which meant that they needed specific answers and solutions. Mid-range to high effect sizes point to the areas in which the experiences of the beginners might be enhanced, including task clarity and satisfaction (refer to Table: 1 and Figure: 3).

**Analysis-2:** Intermediate and beginner users had a similar opinion with ease of use and understandability. But, intermediate users used a large effect size and completed tasks faster, indicating that they become efficient through experience. The differences in the other metrics were not statistically significant, but the intermediate users tended to find the tasks better understandable and fulfilling (presented in Table: 2 and Figure: 4).

**Analysis-3:** The AI tool has been found less complicated and easier to use by beginners to learn data visualization tasks. However, intermediate users had a shorter time to complete the tasks, and they perceived the tool to be more effective. Satisfaction of both groups remained different, with intermediate ones being more concerned with efficiency and novices favoring simplicity and clarity (as depicted in Table: 3 and Figure:5).

**Table 1.** Usability Analysis of Learning Python Concepts by AI tool

Sr/	Key Metrics	Users' level	Mean score	Standard Deviation	T-test / p-value	Cohen's d	Conclusion	Percentage Distribution
1	Ease of use	Beginners Intermediate	3.4 4.6	1.52 0.99	0.1660	-0.96	not significant, moderate effect size	(4: 40%, 5: 20%, 3: 20%, 2: 10%, 1: 10%) (5: 80%, 3: 20%)
2	Understandability	Beginners Intermediate	3.2 4.2	0.45 0.55	0.0022	-2.8	Significant, large effect size	(5: 80%, 4: 20%) (5: 60%, 4: 40%)
3	Time taken	Beginners Intermediate	4.2 4.8	0.84 0.45	0.1950	0.89	not significant, moderate effect size	(5: 40%, 4: 40%, 3: 20%) (5: 100%)
4	Effectiveness	Beginners Intermediate	3.2 4.6	0.84 0.55	0.0140	-1.98	Significant, large effect size	(4: 40%, 3: 40%, 2: 20%) (5: 60%, 4: 40%)
5	Satisfaction	Beginners Intermediate	3.2 5.0	0.84 0.0	0.0013	-3.04	Significant, large effect size	(4: 40%, 3: 40%, 2: 20%) (5: 100%)

**Figure 3.** A sample for Beginners and Intermediate students for Task 1: Understanding Python Variables

**Analysis-4:** In the case with highly complex tools such as linear regression, neither group considered the tool user-friendly at all, but intermediates rated the tool to be slightly higher in terms of effectiveness and satisfaction. There were no significant differences in most measures, indicating that both groups need easier and more comprehensive explanations of complex issues (which are indicated in Table: 4 and Figure: 6).

## 5 Conclusion

This paper will discuss the impact of AI tools, such as ChatGPT, on the process of learning such complex topics as Python programming and Data Science. Through a close scrutiny of the usage of these tools among undergraduate students in the Shah Abdul Latif University, we have been able to learn some interesting facts. The findings indicate the distinction between non-experts and experts. The AI tools are more likely to benefit intermediate users as they are already conversant with the technology. These tools are more likely to be easier to comprehend, more productive, and more fulfilling to them. Conversely, new users usually find it hard to learn and operate the tools. The major difference is the time required to accomplish tasks - intermediate users tend to be more efficient and faster. In general, this study can demonstrate how AI can be used to improve learning, particularly in individuals with some prior exposure to the technology.

### 5.1 Recommendations for Future Improvement

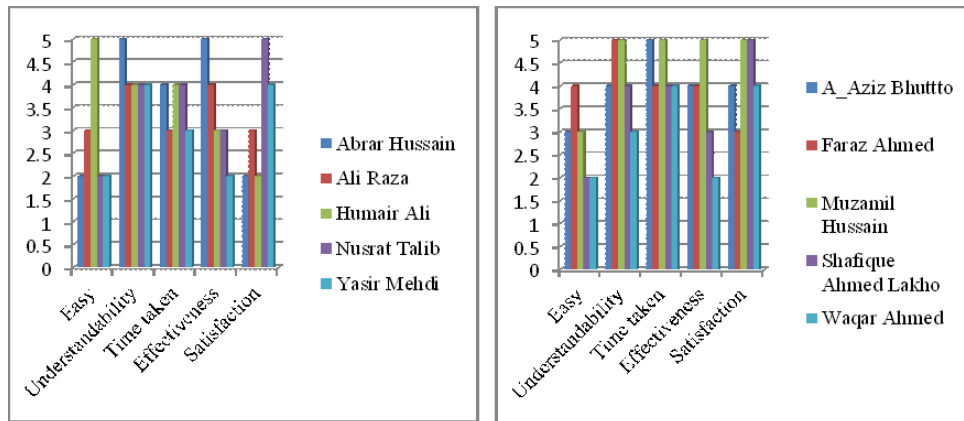
**Adaptive Features:** Build an adaptive learning system that includes gamified elements such as coding challenges and dynamic systems to adapt the explanations based on the level of knowledge of the users so that beginners receive simplified answers and middle level users receive detailed information.

**Interactive Enhancements:** Apply multimedia technology (visual aids, interactive simulations, custom study plans, and instant feedback mechanisms) to have a more efficient learning environment.

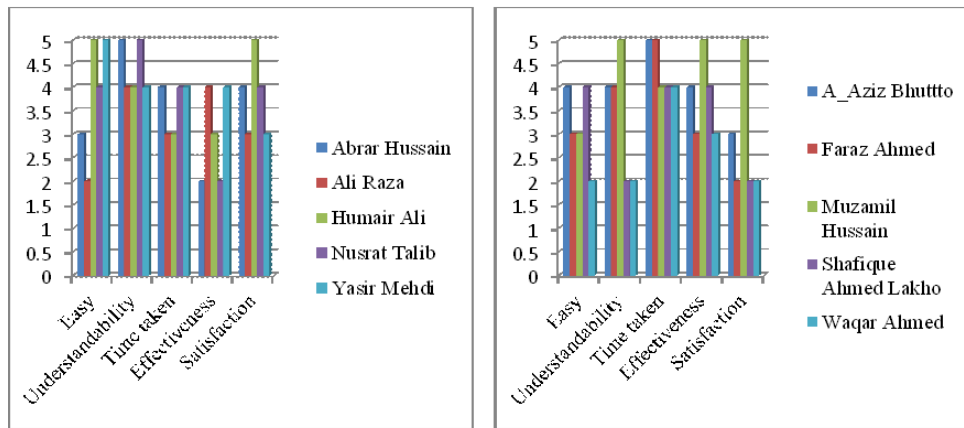
**Task Customization:** Customize tasks with machine learning to serve various user needs and fill the gaps between the beginner and intermediate experiences.

**Table 2.** Assessing Usability of AI tool for Generating a Basic Python Program to Compute List Averages

S#	Key Metrics	Users' Level	Mean Score	Standard Deviation	t-statistics	p-value	Cohen's d	Conclusion
2	Ease of use	Beginners	2.8	1.30	0.0	1.0	0.0	No significant difference
		Intermediate	2.8	0.84				
2	Understandability	Beginners	3.2	0.45	0.0	1.0	0.0	No significant difference
		Intermediate	4.2	0.55				
3	Time taken	Beginners	4.2	0.84	-2.31	0.05	1.46	Significant difference with large effect size
		Intermediate	4.8	0.45				
4	Effectiveness	Beginners	3.2	0.84	-0.28	0.79	0.18	No significant difference
		Intermediate	4.6	0.55				
5	Satisfaction	Beginners	3.2	0.84	-1.44	0.19	0.91	No significant difference
		Intermediate	5.0	0.0				



**Figure 4.** A sample for Beginners and Intermediate students for Task 2: Programming task



**Figure 5.** A sample for Beginners and Intermediate students for Task 3: Data Visualization

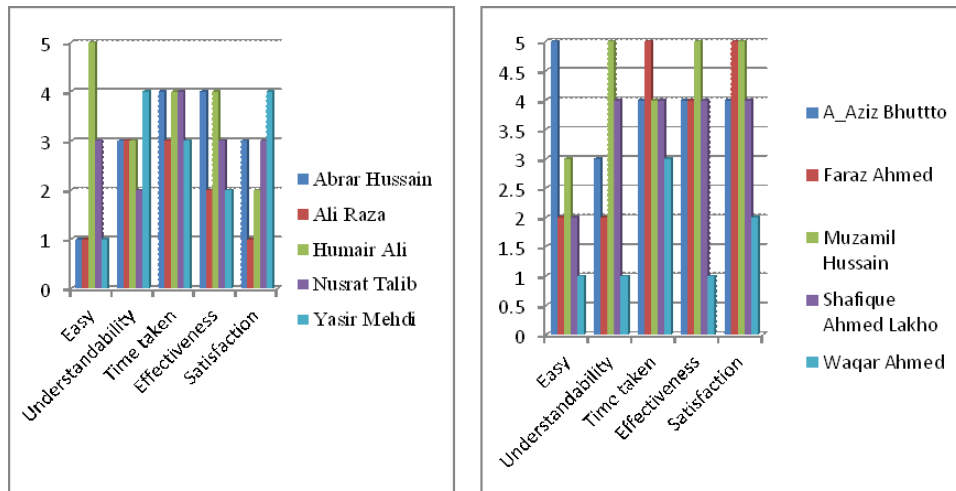
These changes can be implemented to make the learning environment more inclusive and effective. Moreover, it should be emphasized that it is essential to use the empty spaces in usability by creating more intelligent and easier-to-use tools and make user needs the core of all changes.

**Table 3.** Evaluating AI tool's Usability for Learning Basic Data Visualization with Matplotlib

S#	Key Metrics	Users' Level	Mean Score	Std. Dev.	t-statistics	p-value	Cohen's d	Conclusion
1	Ease of use	Beginners	3.8	1.30	0.87	0.41	0.55	No significant difference
		Intermediate	3.2	0.84				{4: 80%, 3: 40%, 2: 20%}
2	Understandability	Beginners	4.4	0.55	1.54	0.16	0.98	Moderate effect, No significant difference
		Intermediate	3.4	1.34				{5: 20%, 4: 40%, 2: 40%}
3	Time taken	Beginners	3.6	0.55	-2.31	0.05	-1.46	Significant difference, large effect
		Intermediate	4.4	0.55				{5: 80%, 4: 20%}
4	Effectiveness	Beginners	3.0	1.00	-1.37	0.21	-0.87	Moderate effect, not significant
		Intermediate	4.6	0.55				{3: 40%, 4: 40%}
5	Satisfaction	Beginners	3.8	0.84	1.44	0.19	0.91	Moderate effect, not significant
		Intermediate	2.8	1.30				{2: 60%, 3: 20%}

**Table 4.** Usability Assessment of AI tool for Learning Core Data Science Concepts; A Focus on Linear Regression and Data Normalization

S#	Key Metrics	Users' level	Mean score	Standard Deviation	t-statistics	p-value	Cohen's d	Conclusion	Percentage Distribution
1	Ease of use	Beginners	2.2	1.79	-0.38	0.71	0.24	Not significant, small effect	{1: 60%, 3: 20%, 5: 20%}
		Intermediate	2.6	1.52					{1: 20%, 2: 40%, 3: 20%, 5: 20%}
2	Understandability	Beginners	3.0	0.71	0.0	1.0	0.0	Not significant, no effect	{3: 60%, 2: 20%, 4: 20%}
		Intermediate	3.0	1.58					{1: 20%, 2: 40%, 3: 20%, 4: 20%, 5: 20%}
3	Time taken	Beginners	3.6	0.55	-1.0	0.35	0.63	Not significant, medium effect	{3: 40%, 4: 60%}
		Intermediate	4.0	0.71					{3: 20%, 4: 60%, 5: 20%}
4	Effectiveness	Beginners	3.0	1.0	-0.74	0.48	0.47	Not significant, small effect	{2: 40%, 3: 20%, 4: 20%}
		Intermediate	3.6	0.55					{1: 20%, 4: 60%, 5: 20%}
5	Satisfaction	Beginners	2.6	1.52	1.87	0.10	1.18	Marginally non-significant large effect	{1: 20%, 2: 20%, 3: 40%, 4: 20%}
		Intermediate	4.0	1.22					{2: 20%, 4: 40%, 5: 40%}



**Figure 6.** Usability Assessment of AI tool for Learning Core Data Science Concepts; A Focus on Linear Regression and Data Normalization

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### Author Contributions

**Asadullah Kehar:** Methodology, Software Implementation, Writing Original draft, Visualization, Data Curation, Validation. **Ahsanullah Abro:** Supervision, Conceptualization. **Shereen Fatima:** Writing Reviewing, Software Editing.

### Compliance with Ethical Standards

It is declared that all authors don't have any conflict of interest. Furthermore, informed consent was obtained from all individual participants included in the study.

### References

- [1] J. Kim, H. Lee, and Y. H. Cho, "Learning design to support student-ai collaboration: perspectives of leading teachers for ai in education," *Education and Information Technologies*, vol. 27, no. 5, pp. 6431–6457, 2022.
- [2] U. Mittal, S. Sai, V. Chamola, and Devika, "A comprehensive review on generative ai for education," *IEEE Access*, vol. 12, 2024.
- [3] M. A. Cardona, R. J. Rodríguez, and K. Ishmael, "Artificial intelligence and the future of teaching and learning." U.S. Department of Education Report, 2023.
- [4] A. Bozkurt *et al.*, "Speculative futures on chatgpt and generative artificial intelligence (ai): A collective reflection from the educational landscape," *Asian Journal of Distance Education*, vol. 18, no. 1, pp. 53–76, 2023.
- [5] S. A. D. Popenici and S. Kerr, "Exploring the impact of artificial intelligence on teaching and learning in higher education," *Research and Practice in Technology Enhanced Learning*, vol. 12, no. 1, pp. 1–13, 2017.
- [6] G. Fischer, J. Lundin, J. Ola, and J. Lindberg, "Rethinking and reinventing learning, education, and collaboration in the digital age." <https://graderesearch.umu.se/forskarskolan-grade/conference2019/>, 2019.
- [7] H. E. Sari, B. Tumanggor, and D. Efron, "Improving educational outcomes through adaptive learning systems using ai," *International Transactions on Artificial Intelligence*, vol. 3, no. 1, pp. 21–31, 2024.
- [8] S. R. Sayma, "Creating effective multimedia learning material with ai for k12 learning & meaningful learning," 2024.
- [9] M. Hakimi and A. K. Shahidzay, "Transforming education with artificial intelligence: Potential and obstacles in developing countries," *Preprints*, 2024.
- [10] M. J. K. O. Jian, "Personalized learning through ai," *Advances in Engineering Innovation*, vol. 5, no. 1, pp. 16–19, 2023.
- [11] W. Holmes, M. Bialik, and C. Fadel, "Artificial intelligence in education: Promise and implications for teaching and learning." <https://www.researchgate.net/publication/332180327>, 2019.
- [12] A. K. Kordon, "Data science based on artificial intelligence," in *Applying Data Science*, pp. 3–37, Springer, 2020.
- [13] T. Zhuang and Z. Lin, "The why, what, and how of ai-based coding in scientific research." <https://www.nature.com/articles/s41551-024-01185-8>, 2024.
- [14] O. E. Molina, D. R. Fuentes-Cancell, and A. García-Hernández, "Evaluating usability in educational technology: A systematic review from the teaching of mathematics," *LUMAT: International Journal of Math, Science and Technology Education*, vol. 10, no. 1, 2022.

- [15] R. R. Saqr, S. A. Al-Somali, and M. Y. Sarhan, "Exploring the acceptance and user satisfaction of ai-driven e-learning platforms," *Sustainability*, vol. 16, no. 1, 2024.
- [16] C. A. G. da Silva, F. N. Ramos, R. V. de Moraes, and E. L. dos Santos, "Chatgpt: Challenges and benefits in software programming for higher education," *Sustainability*, vol. 16, no. 3, 2024.
- [17] Y. Park and M. Y. Doo, "Role of ai in blended learning: A systematic literature review," 2024.
- [18] A. Almufarreh, "Determinants of students' satisfaction with ai tools in education: A pls-sem-ann approach," *Sustainability*, vol. 16, no. 13, 2024.
- [19] H.-C. Chu, G.-H. Hwang, Y.-F. Tu, and K.-H. Yang, "Roles and research trends of artificial intelligence in higher education: A systematic review of the top 50 most-cited articles," 2024.
- [20] D. Zheng, "The criteria of chinese regulatory framework on artificial intelligence: Reflections based on cost-benefit analysis," *Preprints*, 2023.