Ascertaining Educational Efficacy in using Free Open-Source Software Research Artificial Intelligence Tools: A Formulative Study at CPGS-AS, CAU(I), Umiam, Ri-Bhoi, Meghalaya

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ABSTRACT

Writing and publishing research papers is a significant challenge for students, requiring systematic approaches, analysis, and synthesis of research. Proficiency in artificial intelligence (AI) has become crucial in academic research, yet its application remains underexplored. This study assessed the awareness and efficacy of Free and Open-Source Software (FOSS) AI tools among M.Sc. (Ag.) students at CPGS-AS, CAU (I), Meghalaya, using a formative research design and a convenient sample of 62 respondents. Findings revealed that 67.74% of respondents were aware of software ownership, while 75.80% recognized the freedom associated with FOSS tools. Social media and the internet were the primary sources of knowledge for 67.2% of students. However, 79.03% showed low awareness of using FOSS AI tools in academic research. A significant improvement in efficacy was observed after the intervention, highlighting the potential of FOSS AI tools to enhance academic research capabilities among students.

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Keywords: Artificial intelligence, Free and Open-Source Software (FOSS), Awareness, Effectiveness, Students

INTRODUCTION

An automated device capable of simulating human cognitive processes, such as learning, reasoning, and self-correction, is classified under the broad domain of Artificial Intelligence (AI) (Popeniciand Kerr, 2017). AI has demonstrated its potential to enhance student learning by offering personalized educational experiences tailored to individual needs, thereby improving academic performance (Hanaysha*et al.*, 2023). Additionally, AI fosters the development of critical skills such as critical thinking, problem-solving, and creativity by creating collaborative environments where students can engage in problem-solving and project development activities (Melo*et al.*, 2022; Alfalah, 2023). Beyond education, AI significantly contributes to academic research by improving efficiency and effectiveness across various fields. It facilitates the analysis and interpretation of extensive datasets, enables the creation of simulations and scenarios, and supports the clear communication of research findings (Alshater, 2022). However, despite its advantages, a significant barrier to adopting AI-driven learning tools, software, and materials is their cost, particularly in developing countries, as they are often embedded within proprietary systems. Free and Open-Source Software (FOSS) presents a viable solution to overcome these challenges (Gupta and Surbhi, 2018). According to the Free Software Foundation (2009), the concept of "free software" refers not to the absence of cost but to the users' freedom to use, share, and distribute software to benefit the community. FOSS is characterized by its open licensing, allowing users to freely utilize, copy, study, and modify the software. By openly sharing source code, FOSS encourages collaborative efforts to improve software design and functionality (Binjhaand Nayak, 2022).

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A research paper is a type of academic or scientific writing that presents the procedure, in-depth analysis, and interpretation of research on a specific topic, and its creation is a complex and challenging process that demands significant time, effort, and advanced skills (Shrestha *et al*., 2021; Derntl, 2014). Key requirements for writing a research paper include originality, a well-defined methodology, proper formatting, accurate citation, and rigorous analysis, making the process particularly challenging for researchers (Kumar andDhull, 2023). Traditionally, academic research has relied on tedious manual processes to sort and analyse large volumes of text (Dergaa*et al.*, 2023; Nara *et al.*, 2022). However, the advent of AI has significantly simplified scientific writing (ElsalamandMomen, 2023). AI-powered tools assist researchers by enhancing originality, improving writing quality, generating ideas, translating text, and managing references and citations efficiently. Furthermore, these tools enhance the readability of research papers and significantly reduce the workload for students. Some key FOSS AI-driven tools include: ChatGPT, an AI-powered tool, is designed to assist in various tasks such as writing, debugging, and drafting essays (Baidoo-Anu and Owusu Ansah, 2023; Tung, 2023). Quill Bot is an AI-powered paraphrasing tool that helps avoid plagiarism and improves academic writing quality (SyahnazandFithriani, 2023). Sci-Space analyses scientific literature to identify key concepts and trends, providing suggested phrases, keywords, and citations for academic documents (Chandha *et al*., 2023). Mendeley, a reference management software, offers features like bibliographies, collaboration, and annotations (Singh *et al*., 2022). Zotero is a free, open-source tool that allows researchers to collect, organize, and analyse research, integrates with web resources, and offers features like tagging and advanced search options (Behera and Meher, 2022). Although artificial intelligence (AI) has become increasingly important in academic research, there remains a paucity of studies exploring its application and impact. Therefore, the present study was conducted to examine the awareness and ascertain the efficacy of using Free and Open-Source Software (FOSS) AI tools in academic research among M.Sc. (Ag.) students at CPGS-AS, CAU (I), Umiam, Ri-Bhoi, Meghalaya.

Research hypothesis/questions

MATERIALS AND METHODS

The ~~present~~ study employed a formulative research design and adopted a convenience sampling method for data collection. This design was selected to enhance knowledge and familiarity with the phenomenon or subject under investigation. The research was conducted in the Indian state of Meghalaya, located in the northeastern region of the country. The sample comprised 62 postgraduate students from the College of Post-Graduate Studies in Agricultural Sciences (CPGS-AS), Central Agricultural University (CAU), Umiam, Ri-Bhoi, Meghalaya. The present study was conducted to examine the awareness and ascertain the efficacy of using Free and Open-Source Software (FOSS) AI tools. To evaluate the efficacy of these tools, the same group of 62 postgraduate students was invited to participate in a follow-up assessment 15 days after the initial study. However, only 30 participants responded to the post-test. Data for the study were collected using an online questionnaire designed in Google Forms and through an interview schedule. The analysis of awareness levels was conducted by calculating the frequency and percentage distribution of responses. To determine the efficacy of using FOSS AI tools in academic research, and to test hypothesis the non-parametric Wilcoxon Signed Rank Test was employed. The data were analysed using IBM SPSS version 23 and Microsoft Excel 2021.

RESULTS AND DISCUSSION

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DemographicProfile

The demographic profile of the M.Sc. (Agri.) students from CPGS-AS is presented in Table 1. The distribution of respondents by age indicates that the mean age of the participants was 24 years. Rahman and Atikuzzaman (2024), Ocanse*yet al.* (2021) and Alharbi and Tassaddiq (2021) also reported that maximum of the respondents belonged to the 23–25 years age group. This may be due to respondents almost completed their or enrolled into higher education. The gender distribution shows that 81% of the respondents were male, while 19% were female, suggesting active participation from both genders. A similar observation was also reported by Soni (2024),Hettige*et al.* (2022) and Rahman and Atikuzzaman (2024). This imbalance may reflect differences in interest, accessibility, or representation within the specific context or field of study. In terms of the respondents' current level of education, over 50% were enrolled in the second year of their M.Sc. program, followed by 45% in the first year and similar finding also observed by Hettige*et al.* (2022). Regarding the distribution across respective schools, the majority of respondents belonged to the School of Social Sciences (29%), followed by the School of Crop Protection (28%), the School of Crop Improvement (24%) and School of Natural resource management (19%). Rahman and Atikuzzaman (2024) also reported that most of the students participated in the survey from the Faculty of Social Sciences. This pattern may suggest varying levels of interest, relevance, or accessibility of the survey topic among students in these schools.

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Awareness ~~on~~ ofsoftware ownership

The findings presented in Figure 1 indicate significant variation in respondents' awareness of different types of software ownership. It was observed that, (67.74%) of the respondents agreed that they are aware about free and open-source software (FOSS) and 32.25% only respondent was not aware about FOSS. Further, data revealed that (62.90%) of respondents are aware of pirated software, while (51.61%) demonstrate awareness of proprietary software and the results is supported by Nayak and Binjha (2022), Gupta(2018). It is possible for students to use software without being aware that it falls under the category of proprietary or free and open-source software.

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Awareness ~~on~~ ofFOSS AI tools

The findings presented in Figure 2 highlight notable variations in respondents' awareness of various FOSS AI tools used in academic research. The data indicate that a substantial proportion of respondents reported being aware of and utilizing tools such as ChatGPT (85.48%) and paraphrasing tools like QuillBot, Spinbot, and Paraphrasing Online (59.68%) respectively. Findings are lines with the finding of Ahmad *et al.* (2024), Anih and Ukeh(2024), Shofiah and Putera (2024), Loana*et al.* (2024) and Asongo and Terkuma (2024). However, awareness of other AI tools was significantly lower. For instance, only 30.50% of respondents were aware of tools like Chat PDF, Chat Doc, and Explain Paper, while few were familiar with Sci Space (20.97%), reference management software such as Zotero and Mendeley (17.74%), and ORCID iD (12.90%). This suggests a limited level of awareness among students regarding the majority of Free and Open-Source Software (FOSS) options.

Awareness ~~on~~ offeatures of FOSS AI tools

The distribution of respondents based on their awareness of the features of Free and Open-Source Software (FOSS) is presented in Figure 3. The data revealed that only 24.20% of respondents were aware of the FOSS feature emphasizing freedom of use. In contrast, a significantly larger majority, constituting 74.80% of respondents, were not aware of this fundamental feature. The similar results are also reported by Nayak *et al.* (2022). While 64.51% were aware of reliable feature of FOSS and nearly 53.2 % were responded to

available source code. This suggests that while the majority of students may have been familiar with FOSS tools, they lacked a clear understanding of the fundamental characteristics and principles that define Free and Open-Source Software (FOSS).

Source of awareness ~~on~~ ofFOSS AI tools

Figure 4 illustrates the distribution of respondents based on their sources of awareness about Free and Open-Source Software (FOSS) AI tools. The data indicate that the majority of respondents (67.2%) reported gaining awareness of FOSS AI tools through the internet and social media platforms. The findings of the study are in line with the findings of Chao *et al.* (2021), Adarkwah*et al.* (2023) and Kang *et al.* (2022). In their study they also reported that majority of respondents were aware through the internet and social media. In contrast, a considerably smaller proportion (21.3%) indicated that their awareness through courses and academic syllabus. This may be due that informal and digital channels play a more prominent role in disseminating information about FOSS AI tools compared to structured educational programs.

Frequency of usage FOSS AI Research tools

The frequency of usage of FOSS AI research tools is summarized in Figure 5. The data shows that 33.9% of respondents reported rarely using FOSS AI research tools in their academic work. This was followed by 30.6% who indicated using these tools sometimes, 19.4% who used them often, 14.5% who reported never using them, and only 1.6% who reported using them very often. The findings of the study similar to the findings of Khanchandani (2019), Jereb and Urh (2024) and Loana *et al.* (2024). In their study they also observed that respondent rarely using AI tools for their academic purpose.

Level of Awareness ~~on~~ of theuse of FOSS AI Research tools

The level of awareness regarding the use of FOSS AI research tools in academic research is summarized in Table 2. The findings reveal that the vast majority of respondents (79.03%) exhibited a low level of awareness about FOSS AI tools in the context of academic research. In contrast, only 20.97% of respondents demonstrated a high level of awareness. Ventura and Lopez (2024), Alordiah *et al.* (2023), Adarkwah *et al.*, (2023), Musa *et al.*(2020), Abirami and Kavitha (2019) Setiani*et al.* (2021) in there they also observed low level of awareness on AI-powered learning tools, Bibliographic management software, ChatGPT, Digital tools, innovative instructional strategies and Plagiarism Detection Tools among the students of Post graduate students. It is possible that students may utilize software without being aware of whether it falls under the category of proprietary software or Free and Open-Source Software (FOSS).

The efficacy on use of FOSS AI tools in academic research

To determine the efficacy of using FOSS AI tools in academic research, the non-parametric Wilcoxon Signed Rank Test was employed.

Hypothesis testing:

H_0: There is no significant difference in the score of the respondents before and after the class on FOSS AI tools.

H_1: There is significant difference in the score of the respondents before and after the class on FOSS AI tools.

The hypothesis test results, summarized in Tables 3 and 4, indicate a significant difference in the respondents' performance scores before and after the instructional session on FOSS AI tools. The Wilcoxon signed-rank test ($p < 0.05$) revealed that the percentage of successful

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Comment [u15]: There is no significant difference the pre-test and post-test scores before and after the intervention using FOSS AI tools

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Comment [u17]: Intervention

scores improved significantly following the intervention. The sum of positive difference ranks (∑R = 27) was notably higher than the sum of negative difference ranks (∑R = 2), highlighting the positive impact of the instructional session. These findings demonstrate a statistically significant improvement in the respondents' scores after the intervention, underscoring the efficacy of the instructional session in enhancing students' understanding and application of FOSS AI tools in academic research. The result of the study supported by Tella *et al.* (2021, Ahmed*etal.*, (2024), Santiago *et al.*, (2023), Tran and Nguyen, (2022) and Monika *et al.*(2023) highlighted the positive impact of AI-based writing assistants on faculty members' efficiency by providing instant feedback, reducing the time and effort required for proofreading and editing**.**

CONCLUSION

The study highlights the varying levels of awareness, utilization, and efficacy of Free and Open-Source Software (FOSS) and FOSS AI tools among M.Sc. (Agri.) students. Findings reveal that while ~~a~~ majority of students are aware of FOSS, their understanding of its core features and principles remains limited. Moreover, although students show familiarity with commonly used AI tools such as ChatGPT and paraphrasing applications, awareness of other essential tools like reference management software and academic resources remains low. The primary source of awareness for FOSS AI tools appears to be informal channels such as the internet and social media, with structured academic programs playing a less significant role. Furthermore, the frequency of use of FOSS AI tools in academic research remains relatively infrequent, with the majority of students reporting either rare or occasional use. The hypothesis testing using the Wilcoxon Signed Rank Test demonstrated a significant improvement in the students' performance scores after participating in an instructional session on FOSS AI tools. This underscores the positive impact of targeted educational interventions in enhancing students' understanding and effective utilization of these tools for academic research. Overall, the study emphasizes the need for increased awareness, better integration of FOSS education into academic curriculum, and targeted training programs to enhance students' capabilities in leveraging FOSS and FOSS AI tools for academic and research purposes.Educational institutions should incorporate FOSS into ICT curricula and provide training for teachers and students to build proficiency. Technical support for installation, maintenance, and use is essential for sustainable adoption. Professors adopting FOSS can inspire students to integrate these tools into learning. However, many students lack clarity on FOSS benefits over proprietary software and face barriers to its adoption in higher education. Addressing these challenges can enhance awareness and integration of FOSS in academic and research activities.

Recommendation

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Table 1: Demographic information of respondents

Variables	Categories	Frequency	Percentage
Age	20-22	10	16.12
	23-25	40	64.51
	26-28	12	19.35
Gender	Male	50	81
	Female	12	19
Current level of education	M.Sc. 1st year	28	45
	M.Sc. 2nd year	34	55
School	SSS	18	29
	SCP	17	28
	SCI	15	24
	SNRM	12	19

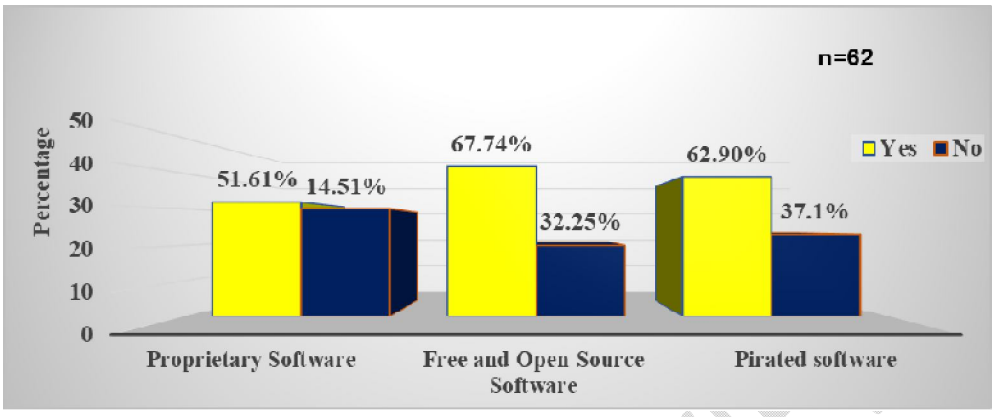

Figure 1: Distribution of respondents According to awareness on software ownership

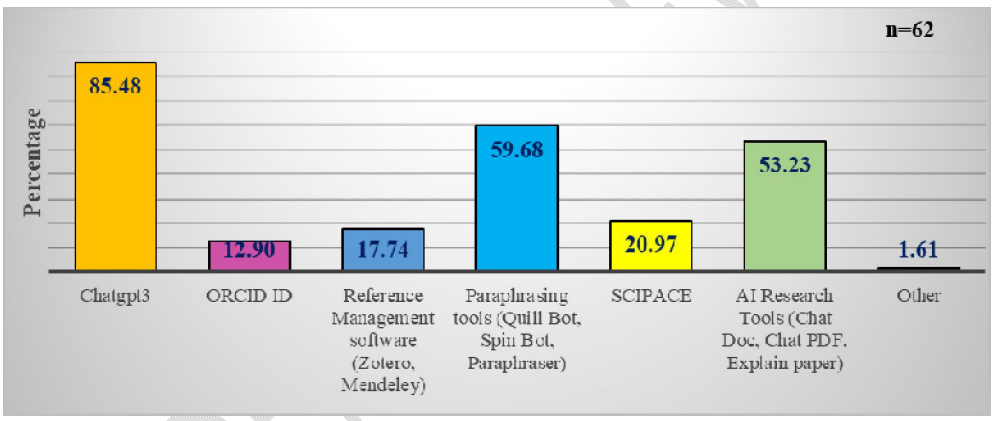

Figure 2: Distribution of respondents According to Awareness on FOSS AI tools

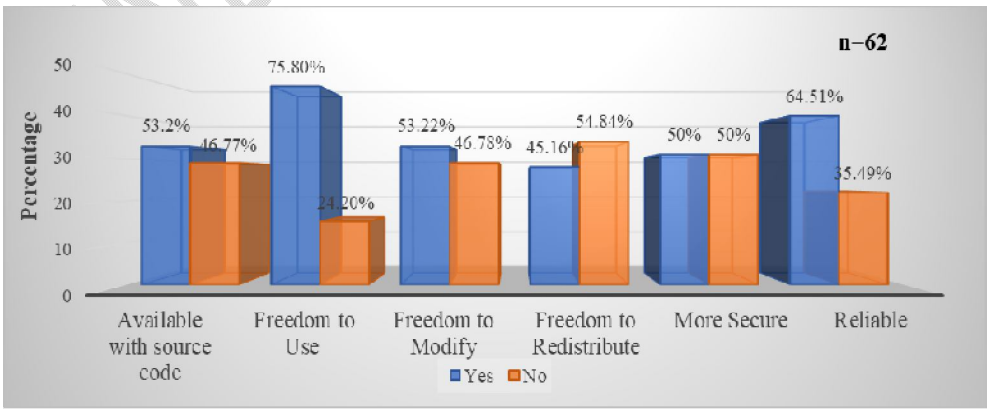

Figure 3: Distribution of respondents According to awareness on features of FOSS AI tools

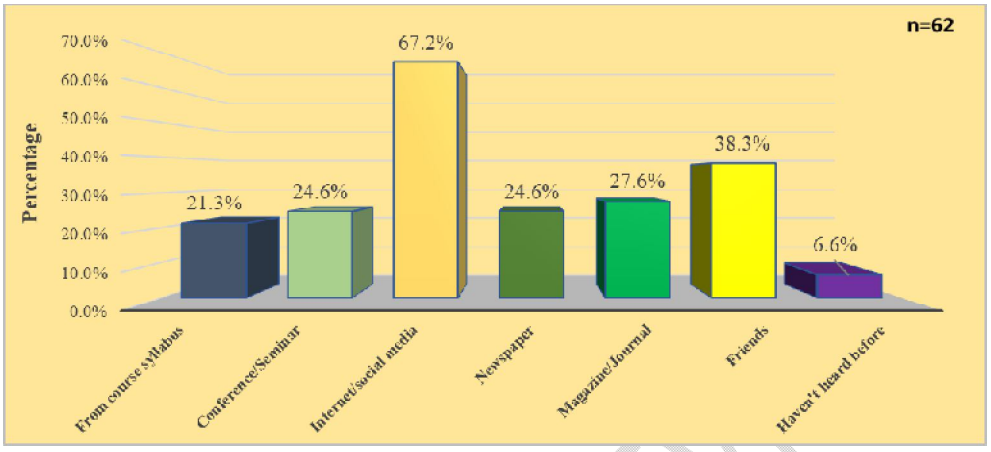

Figure 4: Distribution of respondents According to source of awareness on FOSS AI tools

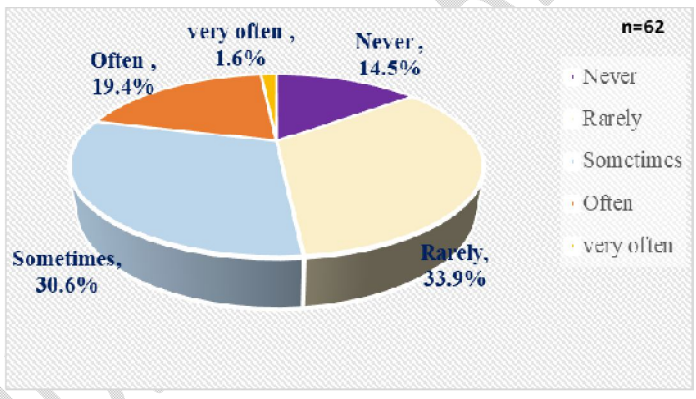

Figure 5: Distribution of respondents According to Frequency of usage FOSS AI Research tools

Table 2: Level of Awareness on use of FOSS AI Research tools

Level of Awareness	Frequency	Percentage
High	13	20.97
Low	49	79.03

Table 3: Hypothesis Test Summary

Asymptotic significances are displayed. The significance level is 0.05				
	Null Hypothesis	**Test**	**Sig.**	**Decision**

1	The median of differences between Before and After equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.
The significance level @ 0.05.				

Table 4: Result of Wilcoxon Signed Rank Test on use of FOSS AI tools in academic research

		n	**Mean Rank**	**Sum of Rank**
After - Before	Negative Ranks	2	11.75	23.50
	Positive Ranks	27	15.24	411.50
	Ties	1		
	Total	30		