RESEARCH ARTICLE

Enhancing Statistics Support with Artificial Intelligence

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Abstract

The integration of artificial intelligence (AI) technologies is revolutionising traditional methods of teaching and learning. The University of the West of England, Bristol, has developed a generative AI policy that encourages AI literacy, personal learning and creativity. In accordance with this policy, we demonstrate use of AI within an established help drop-in service at the university. Data analysis advice from statisticians is provided to students via a newly formed 'Stats Clinic' which aims to act as a triage service within the institution's existing 'espressoMaths' service, open to all.

With appropriate student preliminary engagement, including the use of AI, the productivity and value of student-academic discussions can be greatly increased. Detail is given of how students can use artificial intelligence to get the most out of pre-visit engagement and therefore ultimately their visit with a statistics professional.

Examples where students have applied varying levels of engagement with pre-visit recommended actions are discussed, with empirical evidence from the sessions indicating that those embracing AI are more aware of their data analysis and can comprehend advice more readily.

Keywords: drop-by station, statistical test selection, ChatGPT, generative AI.

Introduction

In today's educational landscape, the integration of artificial intelligence (AI) technologies is revolutionising traditional methods of learning. Educational institutions and academics are increasingly encouraged to adopt AI-driven solutions to enhance student engagement, improve learning outcomes, and streamline administrative processes (Hargrave, Fisher and Frey, 2024).

The authors of this paper have been involved in the discussions relating to the principles for using generative artificial intelligence, as part of the AI Community of Practice and Working Group at the University of the West of England, Bristol (UWE Bristol). These principles were formally adopted during the 2023-2024 academic year. "*UWE Bristol is committed to harnessing the transformative potential of generative AI to enhance learning, teaching and assessment. We aim to support students and staff to become AI-literate, equipped to drive progress and innovation through the ethical use of these powerful technologies.*" (UWE Bristol Principles for using generative artificial intelligence, 2024).

This paper focuses on the development and implementation of a drop-by station, 'Stats Clinic', specifically designed for handling statistics queries in a university setting, supported by preliminary student engagement with ChatGPT (OpenAI, 2023). The aim of this initiative is to provide students with an efficient and accessible platform to seek assistance with their statistical inquiries before engaging with human tutors or faculty members. By leveraging AI technologies, students can receive immediate feedback, access resources, and gain insights into complex statistical concepts, thereby facilitating a deeper understanding of the subject matter.

Previous offering and rationale for change

Since 2008, the university has offered a mathematics and statistics drop-in session called espressoMaths. The service is open to all members of the university community and is usually held around lunchtime each weekday during term time. The physical presence is held in various heart zones of the university, is accessible and user-friendly. It allows spontaneous attendance, no booking system is in place. As such it is designed that interactions are brief to ensure that no student must wait more than 5-10 minutes. The website provides detailed schedules where mathematicians or statisticians are available so that users can visit the most appropriate member of the espressoMaths team.

The most common query Statisticians are asked at espressoMaths and via other communications such as email is how to analyse a dataset. Often users:

- struggle to articulate their research question and study design;
- have had little education in statistics or have not fully engaged with the teaching;
- expect to be performing 'advanced' statistical techniques within minutes;
- are passive users of statistics expecting detailed instructions from the academic.

There was a need to develop a consistent and efficient approach to assisting users of statistics. Some statistics advisors on the espressoMaths service have previously spent significant time guiding users through an entire process in a way that restricts student engagement and is poor use of the time. Other providers of the service consider themselves to be part of a triage service identifying user needs and prescribing solutions, akin to the statistician being the 'General Practitioner' and the visitor being the 'patient'. However, this has been a challenge for patients with extensive needs and there are many patients requiring repeat prescriptions. Records show that over half of all 'espressoMaths' interactions are 20 minutes or more, with many lasting a full hour; this conflicts with the founder's original 'espresso' vision of timely assistance (Henderson and Swift, 2011).

Modern advances in technology and the challenges faced in dealing with statistical queries mean that the existing structure of espressoMaths is no longer adequate for handling data analysis queries. Given the established brand of espressoMaths and its reputation for adding value throughout the university, the development of a Stats Clinic is best initiated and grown within this framework. Additionally, statistics academics receive numerous ad-hoc queries via email that lack a recognised management process. A Stats Clinic could provide a structured outlet for these inquiries.

Some preliminary work by the user would help manage the high demand on statisticians and reduce the need for extensive initial effort. This preparation encourages users to clearly articulate their research questions and study design. The Stats Clinic aims to oversee and support students in using ChatGPT to identify appropriate analyses for their data.

It is important to note that we are not suggesting that ChatGPT can be used to do work for the student, instead we suggest it is used to gather advice. Likewise, we are not proposing that ChatGPT can replace a qualified statistician, instead it can be used to assist in the teaching process.

Stats Clinic offering

Following consultation with the espressoMaths coordinator and the statistics team, the Stats Clinic at UWE Bristol was established and has been running since October 2023. A summary of the process is given in Figure 1.

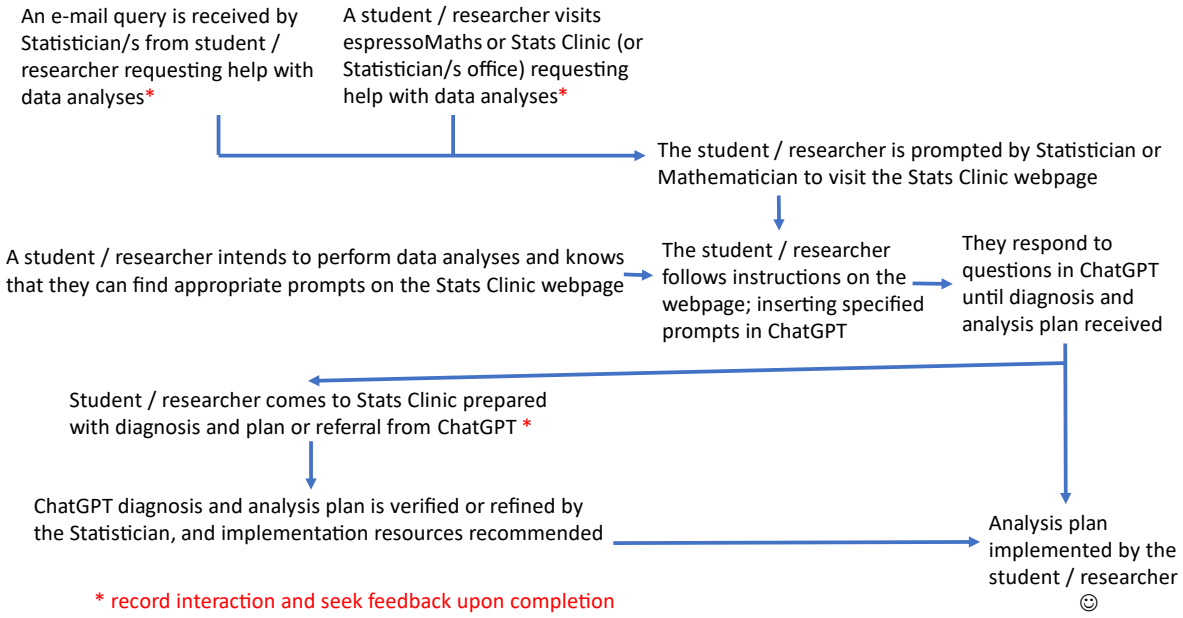

Figure 1. Stages of engagement in the Stats Clinic process.

We aim to introduce some concepts of ethical use of AI by describing an appropriate use of AI as a learning tool. Given in Figure 2 is an extract of the instructions to those with data analyses related queries, as provided to users on the espressoMaths website (UWE Bristol Mathematics and Statistics Study Skills, 2024). This details the preliminary engagement required prior to attending a Stats Clinic session. The prompts are an extension of those presented by Owen (2023), and are similar to the prompts developed by Goodale (2024).

Students are directed to seek further guidance relating to responsible use of AI from their module handbook or assessment guidelines.

Understanding your research question

Prior to your interaction with ChatGPT (or a Stats Clinic advisor) you will need to identify your research question. You should have an awareness of what you are trying to measure or predict (response variable), and what factors you have or will collect data for that could impact measurements of that variable (explanatory variables). When you have an understanding of what you are trying to achieve, then you will be in a position to interact with ChatGPT.

Recommended prompts

Insert the following prompt into ChatGPT:

I am going to ask a question about statistics. When answering me use the following approach: 1. Make your explanations comprehendible by an undergraduate degree student 2. Ensure your responses are precise and based on recognized knowledge. 3. Consult a variety of sources and contexts. 4. Avoid advancing societal stereotypes or biases. 5. State uncertainty if the answer isn't clear-cut. 6. Focus strictly on the subject without digressing. 7. Recommend exploratory data analyses and statistical tests I should perform. 8. Ask me questions one at a time until you thoroughly understand my research question and study design before providing a solution.

Here is my research question: **[insert details about what you are trying to achieve and what data you have / will have]**

ChatGPT will ask some important questions to gain an understanding of your research question and data collected. Please respond to each question fully, asking ChatGPT for clarification of a question where required.

ChatGPT will provide a solution, read and review its recommendations. We suggest that you further interact with ChatGPT using some of the following prompts that we have found useful:

- Please show me how to do **[insert name of analysis recommended by ChatGPT]** in **[insert the name of the statistical software you use]**;
- Please inform me how to interpret the results of **[insert name of analysis recommended by ChatGPT]**;
- What do you mean by **[insert any terminology used by ChatGPT that you do not understand]**?;
- Is there anything else that I should consider?

If you are happy with the solution then there may be no need to visit the statistician, however you may still wish to do so to check the advice given.

You may receive a referral from ChatGPT to see a statistics specialist, or would otherwise like further verification of the response from ChatGPT from a statistician. If this applies then please do visit the Stats Clinic in person. When visiting the Stats Clinic you should bring your ChatGPT conversation with you to speed up the process in the Stats Clinic. Please be advised that if you visit the Stats Clinic without evidencing your interaction with ChatGPT, we will direct you to this page to complete the suggested prompts in ChatGPT.

Figure 2. Stats Clinic preliminary engagement instructions on espressoMaths website.

Typical interactions during drop-in sessions

Users at Stats Clinic were generally undergraduates studying non-statistical subjects, seeking assistance with a final-year dissertation or a second-year statistics analysis project.

The following summarises the typical types of user who present at the Stats Clinic and the effectiveness of the service for each type.

1. The Traditionalist

Occasionally, students and staff revert to traditional methods used before the establishment of the Stats Clinic, such as discussing problems step-by-step and recommending books. These interactions often lead to students attending multiple sessions, relying on traditional textbooks for reference, and engaging in time-consuming exchanges. The repeated need to cover the same concepts suggests that the communication may be ineffective.

2. The Chancer

Many users had not initially engaged with preliminary activities, including those seeking step-by-step guidance. Statisticians directed these students to complete preliminary activities and use ChatGPT, which was generally well received. This approach effectively encourages students to become self-sufficient by utilising AI tools.

3. The Premium Payee

A few students engaged with AI before visiting the Stats Clinic by subscribing to premium AI services not recommended by us. These students reported that the paid version of ChatGPT (Century) provided inconsistent results and caused further confusion. This indicates that our preferred, widely accessible approach is at least equally effective, and there appears to be no clear advantage currently for those who opt for more expensive services. However, user experiences with AI may vary, including the value of paid versions. The relative benefit of different versions of AI and the potential disparity between those that can afford premium versions and those that cannot, is something that should be continually monitored.

4. The AI Apprehensive

Some users did not engage with preliminary activities due to concerns about AI accuracy. During interactions, guiding these users through data analysis with ChatGPT and verifying the results led to positive feedback about AI's usefulness. Demonstrating AI's reliability can ease apprehensions and encourage greater engagement.

5. The Casual AI User

Some students were eager to interact with ChatGPT but do not use it effectively, especially those who do not follow suggested prompts and end up confused by the results. This confusion is often resolved by encouraging students to think more carefully about their ChatGPT prompts. Ensuring that students use appropriate prompts and understand context-specific nuances is essential for effective AI use.

6. The Fully Engaged

Several users engaged deeply with preliminary activities and followed the advice as intended. These users demonstrated a high level of comprehension and used the service to

confirm their understanding. This straightforward process also allowed time for discussing concepts beyond the basics, guided by AI. This highlights the potential of AI tools to enhance learning outcomes when fully utilised, and the additional value a statistician can provide once the basics are covered by AI.

Discussion

The number of users visiting the Stats Clinic subsidiary of espressoMaths in the 2023-24 academic year is estimated to be around 30-40. We believe this represents a drop in the frequency of visits based on previous iterations of the statistics provision at espressoMaths. The number of users being helped by the AI prompts we provide without then visiting a statistician in-person is difficult to quantify, it is likely that many users are benefiting from the service without direct interaction.

Initial concern that the student body might view the approach as ‘lazy’ or ‘cost-cutting’ has been alleviated by the highly supportive student reaction to the service, verbal student comments during the sessions include:

“It’s great to see someone using it [ChatGPT]”;

“Very useful for my project, great use of ChatGPT showing me how to use it correctly and efficiently to help me solve a range of statistical problems and data analysis problems”;

“ChatGPT should be used in all lectures, Education is always behind on new technology”;

“I wouldn’t have been able to do this without ChatGPT”;

“That’s so cool! ChatGPT is useful for some things. Fab. I was going to email but this is really useful”.

Formal written feedback is requested on the website but is only recorded if the user chooses to engage with the survey. The number of users providing formal written feedback has been low, but overwhelmingly positive as shown in Table 1.

Table 1. Number of responses to the question, “How would you rate your espressoMaths experience today?”, in each of the last three academic years.

Academic year	Extremely positive	Somewhat positive	Neutral	Somewhat negative	Extremely negative
2023-2024	12	2	0	0	1
2022-2023	15	0	0	0	0
2021-2022	22	4	0	0	0

The student who responded negatively stated:

“*I would like it if the session was more interactive and helpful […] he seemed like he didn't want to help me much”.*

The negative feedback suggests that there may be a stigma to overcome for some students regarding the use of AI, and the perceived reduction in human contact.

The stigma against AI is not confined to some sections of the student body, many staff are also yet to fully embrace AI capabilities. In one interaction, a PhD student arrived with what the statistician viewed to be important research; given the level and importance of the research the statistician *'in the moment felt too embarrassed to suggest ChatGPT'*, even though all the questions and approaches were straightforward and could have been handled by AI more efficiently than the statistician. Many academics are not mentioning AI at all. Further research into staff perceptions of AI, and development of staff training strategies, is required.

Our experience is that when students use our suggested prompts, the responses from ChatGPT have excellent accuracy. However, limitations of the approach are that we do not know how many students are using AI as advised, and we cannot be sure of the accuracy of the guidance received by those that do not seek verification from an expert statistician.

Conclusion and Recommendations

Most of the demand for the Stats Clinic drop-in sessions is related to final year projects. Project-Based Learning (PBL) plays a crucial role in modern education by offering students immersive, hands-on experiences that go beyond rote memorisation and encourage critical thinking, problem-solving, and independent thought (Derrick and Weir, 2024). Integrating AI-driven drop-in sessions within PBL frameworks can significantly enhance the learning process.

AI provides real-time support and guidance to students as they navigate complex project challenges, offering insights, resources, and feedback tailored to individual needs. By leveraging AI capabilities such as automated advice and feedback, drop-in sessions can empower students to delve deeper into project exploration, refine their ideas, and develop essential skills in a supportive and interactive environment. This integration not only enriches the PBL experience but also prepares students for future roles where AI technologies are increasingly prevalent, fostering a holistic and adaptive approach to learning.

The Stats Clinic case study at UWE Bristol demonstrates the transformative potential of AI in enhancing academic support services and improving student outcomes. By leveraging AI technologies responsibly and ethically, educational institutions can create inclusive learning environments that empower students and foster their success. As AI continues to evolve, maintaining a balance between technological innovation and ethical considerations is paramount to ensure AI remains a catalyst for positive change in education. The Stats Clinic approach and similar initiatives should evolve over time as the AI landscape evolves, including new examples and dynamic guidance.

Based on the experiences and insights gained from the Stats Clinic, several recommendations and future directions emerge:

- Promoting AI literacy among students and faculty to maximise the benefits of AI integration, including research into staff and student perceptions;
- Conducting ongoing research and development in AI-driven educational technologies to address evolving student needs;
- Fostering partnerships and collaborations within the AI and education ecosystem to promote responsible AI adoption and innovation. This includes advancing the role of the Stats Clinic as a hub for further education and development in these areas.

Students that we have engaged with throughout this transition generally seem to support the use of AI assistance. Those who follow the Stats Clinic instructions and fully embrace the AI technology have had the most successful interactions and are better prepared for future work environments. In conclusion, incorporation of AI has allowed us to adapt to evolving student needs, provide real-time feedback that helps students learn at their own pace, and reduce statistician time required resulting in staffing cost efficiencies.

References

Derrick, B., & Weir, I. 2024. Project-based learning integrated with e-Assessment. MSOR Connections, 22(2), 12-20. https://doi.org/10.21100/msor.v22i2.

Goodale, T. 2024. Using Generative AI to help with statistical test selection and analysis. MSOR Connections, 22(3). https://doi.org/10.21100/msor.v22i3.1485

Hargrave, M., Fisher, D., & Frey, N. 2024. The Artificial Intelligence Playbook: Time-Saving Tools for Teachers that Make Learning More Engaging. Corwin Press.

Henderson, K., & Swift, T. 2011. espressoMaths: A drop-by station. MSOR Connections, 11(2), 10-13)

Owen, A. 2023 Statistics Support Using ChatGPT: the good, the bad and the.... CETL-MOSR Conference, Cardiff University, 2023.

OpenAI. 2023. ChatGPT (GPT-4) [Large language model]. https://chat.openai.com/chat [accessed 1/09/2023]

UWE Bristol Mathematics and Statistics Study Skills. Available from: https://uwe.ac.uk/study/study-support/study-skills/mathematics-and-statistics [accessed 9/07/2024]

UWE Bristol Principles for using generative artificial intelligence. Available from: Principles for using generative artificial intelligence (AI) - Academic information | UWE Bristol [accessed 12/08/2024]