Editorial

Uncharted Territories: Exploring the Edges of Culture, Science and Learning

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I am Grace Fisher, a final-year medical student at Warwick University and this year's *Reinvention* editor. Working on this edition has been a privilege – not only because of the quality of the research submitted, but because of how clearly our authors embody the spirit of *Reinvention*. Each contribution, in its own way, challenges how we think about knowledge, inclusion and creativity in research.

Across the submissions this year, there is a shared willingness to question assumptions and to imagine something better – whether that is fairer assessment practices, more inclusive systems of support, or new approaches to technology, identity and belonging. What strikes me most is how confidently undergraduate researchers now occupy this space. Their work is not tentative or derivative; it is bold, critical and grounded in lived experience.

IATL at 15

This feels like an especially fitting year to be reflecting on *Reinvention*, as the **Institute for Advanced Teaching and Learning (IATL)** – the journal's home – celebrates its 15th anniversary. Since 2010, IATL has been a space for educational experimentation and collaboration across disciplines. Its ethos is simple but transformative: that students are not just the audience for research – they are its authors, its critics and its future.

As Dr Fraser Logan and Professor Jonathan Hickman-Heron write in their piece marking IATL at 15, the institute aims to help students 'see themselves, and be seen by others, as researchers in their own right'. That belief runs

through every page of this journal. IATL has never been about preserving the traditional model of higher education; it is about rethinking it – creating spaces where students and staff work together to test, imagine and reinvent learning itself.

Reinvention as a practice

For me, *Reinvention* is as much a mindset as it is a theme. As a medical student, I see it daily – in the evolving nature of science, in how care is redefined by new evidence, and in how we constantly revisit what 'good practice' means. Research, in any discipline, is built on that same cycle of curiosity and change.

This year's issue captures that energy beautifully. Our authors show that reinvention can take many forms: it can be methodological, like rethinking what counts as valid evidence; it can be social, like widening access to knowledge; or it can be deeply personal, reflecting on one's place within a wider system. In all cases, reinvention is not just about breaking things down – it is about rebuilding something stronger, fairer and more human.

Critical reflections

In this issue, we also have a variety of author reflections on their research, offering critical insights that enhance the depth and rigour of their academic analysis. Our Critical Reflections demonstrate the range and depth of undergraduate enquiry. 'Testing the Limits: Can Nitrate Levels Be Used to Safeguard the Health of UK Rivers? The Critical Reflection of an Undergraduate's Introduction to Independent Research' considers how data and lived experience intersect in environmental science. 'Mysteries for Humans: Navigating the Maze of Science, Objectivity and our Mental Limits' questions what it means to know or measure truth within research itself. Meanwhile, 'Artificial Intelligence and Children's Learning: Exploring the Potential to Support' reflects on how emerging technologies can both enhance and challenge educational practice. Together, they show reflection as an essential act of reinvention.

Looking ahead

Fifteen years on, IATL and *Reinvention* continue to grow together – both grounded in the same belief that education thrives when students are active participants in creating knowledge. This issue is a reminder that research does not have to be remote or abstract; it can be deeply connected to lived experience and driven by empathy and imagination.

A huge thank you to all our contributors, reviewers and the editorial team who made this issue possible. Your enthusiasm and hard work capture exactly what *Reinvention* stands for: learning as a shared act of creativity and change.

Here's to the next 15 years of questioning, collaboration and, of course, reinvention.

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Insights into Diversity: A Multi-Stakeholder Analysis of Inclusive Assessment Practices in Higher Education

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Abstract

Changes to admissions policies may have improved access to higher education, but equitable teaching and assessment strategies must address persisting attainment gaps. A diverse and inclusive assessment strategy is proposed to contribute towards reducing attainment deficits by providing learners with equality of opportunity. This study aims to elucidate student and staff experience of diverse assessments, to involve students in shaping the future of assessments, and to develop recommendations to overcome challenges associated with implementation. To achieve this, a mixed-methods survey (n = 54) explored students' experiences of assessments. Focus groups (n = 7) led by students were conducted with some of the survey respondents. University educators (n = 6) participated in one-to-one semi-structured interviews. Student and staff data were analysed separately and assembled for comparison. Analysis revealed strong agreement between students and staff: both groups considered that diverse assessment would promote equitable opportunities in higher education. Participants recognised the need for a shift in culture to facilitate the implementation of a diverse assessment strategy that would promote equity of opportunity by improving accessibility and inclusivity. Moreover, implementation should be accommodated to the 'learning journey', welcoming students as equal co-creators and seeking to minimise the burden of assessments and marking.

Keywords: Inclusive assessment strategy, equity in assessment design, higher education, student co-creation, degree awarding gaps

Introduction

Recruitment for diversity in the UK aims to enrich academic communities by increasing the demographic heterogeneity of the student population (HEA, 2022; Universities UK, 2023). Despite this progress, the existence of gaps in attainment suggests that persisting obstacles negatively impact the learning experience of formerly under-represented students once admitted to the university, including obstacles in assessment design (Arday *et al*., 2022). Policies promoting inclusivity in admissions have not necessarily been implemented in the core educational business of first-world universities, possibly leading to these attainment gaps (Cotton *et al*., 2015; Leslie, 2005; Richardson *et al*., 2020). Action is required to promote equity of opportunity after recruitment, including rethinking current assessment strategies.

According to anecdotal evidence cited by the British Medical Association (2020), medical students eligible for accommodations due to disability or neurodiversity frequently encounter difficulties in obtaining the reasonable adjustments they need.

The available adjustments, often stereotyped as variations in assessment environments and timings, have been criticised by some who argue they may provide an unfair advantage rather than truly levelling the playing field (Beck, 2022; Elliott and Marquart, 2004). Critics, including

Healey *et al*. (2008), argue that the standard nature of these adjustments lacks theoretical justification, failing to consider the severity or form of neurodiversity such as dyslexia. Additionally, a recent systematic review by Clouder *et al*. (2020) criticises the 'one size fits all' approach, questioning whether these learning support plans effectively meet the individual needs of neurodivergent students. Some assessment types that are relatively impervious to adjustment, like presentations and clinical examinations, reduce equity of access for certain students.

For example, autistic students may struggle with the social components of presentations, including making and maintaining eye contact, and interpreting the emotions and intentions of others (Hand, 2023). Presentations typically rely on oral delivery, which may disadvantage neurodiverse students who experience challenges with speech fluency or managing distractions (Alderson *et al*., 2017; Takács *et al*., 2014).

A modern approach to academic inclusivity and accessibility in learning and assessment should recognise that the diversified needs of the current student population may have broader dimensions than previous cohorts.

Following the enforced changes to learning and assessments due to the COVID-19 pandemic, many universities have largely sought a return to 'business as usual' (Brooks and Perryman, 2023). However, the pandemic-driven accommodations, although imperfect, demonstrated that change is possible when necessary. Reports, such as the one from Quality and Qualifications Ireland (2020), revealed that marginalised groups faced more challenges with remote learning, highlighting the need for ongoing efforts to address inclusivity and accessibility in education.

Diverse assessment

There is no clear consensus on what constitutes diverse assessment. O'Neil and Padden (2022) identified two definitions: a wider variety of assessment types and a choice of assessment methodologies within each module. They also highlighted five obstacles to implementing diverse assessments, with 'fear of students failing' being the least concerning for staff and 'fear of grade inflation' being the most significant, underscoring the need for standardised marking. Contemporary learning and assessment must evolve with technology. Collins and Halverson (2009) argue that technology aims to improve the quality, efficiency and personalisation of learning to meet diverse learner demands. Lim *et al*. (2024) suggest that diverse assessment should include competencies such as the ethical use of artificial intelligence. Bearman *et al*. (2022) designed an e-assessment framework to integrate digital innovation into higher education. Academics broadly agree that diverse assessment uses a range of modalities targeting different types of learning, resulting in varied skill acquisition (Garside *et al*., 2009; O'Neil and Padden, 2022). This approach acknowledges diverse student strengths, learning styles and ways of demonstrating knowledge. A diverse **assessment strategy** also embraces a socio-political approach to addressing disadvantage (Nieminen, 2022), aligning with the social model of disability, which frames disability as a societal failure to achieve inclusivity. Charlton *et al*. (2022) highlighted the inconsistency in policy constructions of programme-level assessment strategies across Australia, emphasising the need for clear implementation guidelines.

Challenges in changing assessment policy include impacts on content delivery, resistance from students and staff, risks of widening the attainment gap, grade inflation, lack of resources and incongruent mark schemes (Armstrong, 2017; Bevitt, 2015; Kirkland and Sutch, 2009; Medland,

2016; O'Neil and Padden, 2022). Unsurprisingly, given these difficulties, the literature acknowledges that the increasing diversity of the student population is not adequately reflected in current assessment practices.

Thus, the aim of this study is to capture the experience and perceptions of students and staff regarding diverse assessment and to suggest practical recommendations for implementing such a strategy, involving students in shaping the future of assessments, and overcoming challenges to benefit the wider community.

This study asks how students and staff comprehend diverse and inclusive assessments, and how these groups perceive the challenges of a diverse assessment strategy. We seek to use the answers to these questions to inform the design of diverse assessments that promote effective learning.

Methods

A mixed-methods survey (n = 54) explored students' experiences of 'diverse assessment' at a research-intensive university in the UK. Two focus groups led by students were conducted with some of the survey respondents (n = 7). University educators (n = 6) participated in one-to-one semi-structured interviews.

The semi-structured focus group interviews (n = 3 and n = 4 participants) were facilitated online by two student researchers, following the guidelines and steps recommended by Stalmeijer *et al.* (2014). At the time of data collection, both facilitators were undergraduate students with some experience of conducting interviews and focus groups. The senior authors, both experienced in mixed-method educational research, provided close oversight. Neither facilitator had a prior personal or professional relationship with the student participants, ensuring a separation that helped minimise bias and promote open dialogue during the interviews. Ethical approval was granted by the Research Ethics Committee of the university where the research was conducted.

Participants and recruitment

Eligible participants included students who had successfully completed at least one year of study and staff involved in teaching or developing assessment strategies. Students with less than one year of study were excluded since most of the data collection took place in the Autumn term, before the majority of first-year students had experienced university-level assessment. Data collection comprised a questionnaire with 54 student responses and two semi-structured focus groups with seven student participants, while staff data was gathered through one-to-one interviews with six staff members. This methodology was deemed appropriate based on similar studies (Dicicco-Bloom and Crabtree, 2006; Dommett *et al.*, 2019; Nolan and Roberts, 2021, 2022). Students were contacted through mailing lists and newsletters to distribute the participant information leaflet (PIL) and questionnaire. The PIL outlined the study's rationale, participation details and withdrawal procedures, assurance that data from both the questionnaire and focus groups would be anonymised and that participation would not affect academic progression. Students interested in discussing their questionnaire responses were invited to the focus groups, with written consent obtained from all participants prior to participation. Staff members from various departments were invited to participate in one-hour semi-structured interviews via their institutional email, following a similar process regarding the PIL and consent forms.

Data collection

Students

The online student questionnaire (n = 54) was hosted on the university's SiteBuilder platform. The final question invited respondents to participate in focus groups. The semi-structured focus group interviews (n = 3 and n = 4 participants) were conducted according to guidelines and steps outlined by Stalmeijer *et al*. (2014) with participants joining online and facilitated by two researchers. Participants had their cameras on and could view and hear all participants and facilitators. Discussions were audio recorded. A semi-structured interview guide with a list of pre-agreed open-ended questions was used to guide the topic of conversation while also allowing participants to speak freely and introduce new considerations (Appendix 1).

Staff

Staff interviews (n = 6) were conducted online using Teams platform with discussions audio recorded. Each interview was conducted by one researcher, and a list of pre-agreed questions (Appendix 2) was used to guide participants' discussion, while also enabling free-flowing dialogue.

Data analysis

Reflexive thematic analysis aims to inform understanding of participants' perspectives and to structure and report themes (overarching patterns) within the dataset (Braun and Clarke, 2006). To elicit the themes, the transcripts were read by the researchers to enable familiarisation. Notable features in the data were then iteratively coded using an inductive approach over two rounds of coding for diligence and consistency (Braun and Clarke, 2012). Patterns and connections were actively sought in the codes, and similar codes were amalgamated inductively, identifying the final themes (Table A2 in Appendix 2). The generated codes, themes and the titles of themes were reviewed and discussed by the full research group to ensure the final themes accurately represented the data. Researchers maintained reflective notes throughout the analysis period, and these were discussed at researcher meetings. Discrepancies and disagreements between researchers were considered and discussed, enabling consensus to be reached. Once themes and codes were established, the final report was produced.

Results

The thematic analysis of student and staff focus group and interview data resulted in the identification of seven common themes across student and staff data. The identified themes were:

1. perceptions of diverse assessment
2. purpose of assessment
3. implementing change to assessment strategy
4. equity, fairness and inclusivity
5. culture shift and co-creation
6. best practice
7. challenges and key considerations.

The identified themes revealed an overlap in the experiences and views of current assessment approaches and future directions between students and staff, although the language and framing used by the two groups differed (Table 1).

Table 1: Results table showing the seven themes identified from the qualitative data.

Theme	Sub-Theme		Quotes		Key Overall Finding
	Students	*Staff*	*Students*	*Staff*	
Perceptions of diverse assessment	• Choice of assessments • Flexibility with deadlines • Workload • Learning a range of skills • Preparing for the world of work	• Choice of assessments • Flexibility with deadlines • Workload • Learning a range of skills • Building on previous learning • Preparing for the world of work	• *'[…] the importance of continuity like somebody should actually have thought about what is the student experience going from […] module A to module Z […]'*	• *'I think **spiral curriculums** are really valuable and have to be underpinned by your assessment strategy, which should have diversity all the way through, but more specific expectations for learning outcomes as you progress up into those different levels.'*	• Diverse assessment should involve methodologies that examine different pedagogic domains and skills, thus augmenting equality of opportunity by accounting for the complex student demographic and needs.
Purpose of assessment	• Learning from assessment – part of the broader 'learning journey' • Arbitrary number • Learn meaningful and transferrable skills • A way of measuring competency • Motivation	• Learning from assessment – part of the broader 'learning journey' • Learn meaningful and transferrable skills • Assessments as a measure of teaching quality • Motivation	• *'I would like assessments to be a part of my learning journey […]'* • *'I think we should be diversifying assessment beyond simply assessment, but also looking at an application of learning as opposed to an assessment of knowledge, while still retaining the assessment of knowledge. If it is important […] Everybody learns differently and everybody needs to be able to demonstrate their knowledge in their own way […]'*	• *'Learning from assessment means that the assessment is not a regurgitation of facts to kind of defend yourself, but it's an opportunity to develop further […]'* • *'[…] a transparency with the students, with how that's going to be assessed and then a development of the skills to allow them then to utilise that particular mode of assessment that you've chosen within the diverse assessments that you might have […]'*	• Each assessment should have a 'purpose', which is to promote learning. The degree to which assessments should measure student competency will depend on the course or subject area and should always be combined with an exercise that facilitates learning.
	• Timing of assessments • Workload • Building on	• Timing of assessments • Workload • Spiral curriculums • Systems and	• *'I have two jobs while I'm at uni. And that just*	• *'[…] my role is not to get students into lecture theatres, my*	• Students and staff felt that transparency regarding the requirements of an assessment and how it will

Implementing change to assessment strategy	previous learning and preparing for next steps • Choice of assessments • Flexibility with deadlines • Struggles with personal circumstances	infrastructure • Choice of assessments • Flexibility with deadlines • Need for improved mitigation procedures and access to reasonable adjustments	*means for me, oftentimes, I cannot invest that same amount of time into my coursework as other people can.'*	*role is to provide the material in multiple formats. And then students can choose how they absorb it, which is then going to be maintained.'*	be marked was important for building trust and confidence. Flexibility with deadlines was seen as a way of promoting student engagement and mitigating health, social and financial pressures.
Equity, fairness and inclusivity	• Equal opportunities to succeed • Accounting for disability, neurodiversity and language differences • Choice of assessments • Flexibility with deadlines	• Equal opportunities to succeed • Accounting for disability, neurodiversity and language differences • Choice of assessments • Flexibility with deadlines • Inclusive assessment follows inclusive teaching (e.g. provision of materials in multiple formats)	• '[inclusive assessment means] *assessment types and options which work for everyone, including those with extra needs or from different backgrounds.'* • *'[…] why am I thinking about grammar in exam which is about human biology […]'*	• *'*[inclusive assessment] *means that there is not one particular cohort of students that is disadvantaged by the choice of diversity that you use for your assessment strategy.'* • *'[…] Simple old old-school exams. Memorise this. Regurgitate it […] No […] that's not promoting student learning.'*	• The ideal assessment strategy should be inclusive and should use reasonable adjustments and compassionate mitigation policies to reach an equitable equilibrium allowing all students to succeed based on effort, regardless of background, health status, neurodiversity, caring responsibilities or financial status.
	• Shift from traditional assessments to more radical, diverse	• Shift from traditional assessments to more radical, diverse assessment • Concerns about academic integrity • Students should be involved more	• *'I think because assessment is a tricky topic to ask for student feedback and, you know, it's hard for students to have input in the assessment […]'* • *'I just think it's sometimes hard for whoever is*	• *'My view is diverse students and inclusive representation […] my view is not a load of white middle-class students basically who are all getting firsts […] I don't want that. What I want is students basically who are neurodiverse; I want students who are from lower socioeconomic backgrounds; I want students who represent*	• Staff and students advocate for collaboration and co-creation of assessments. Both groups

Culture shift and co-creation	assessment • Concerns about academic integrity • Students should be involved more in designing and trialling assessments, and policy making	in designing and trialling assessments, and policy making • Concerns that students recruited may not fully represent diverse student population • University politics and hierarchies • Problems with 'inheriting modules' • Struggle to make change	*creating an exam which is understandable to put themselves in the shoes of a student taking that assessment equally as it is hard for me to put myself in the shoes of someone who is creating that assessment and trying to make it span all the rules and regulations and intentions for that module […]'*	*each […] all the, I think, minorities.'* • *'It would probably involve more compassionate practice just generally across the board, compassionate practice with students, compassionate practice from colleagues to colleagues. I would love to see the students more involved in these things.'* • *'It would just save so much time and so much panic if you just got the student voice in and we don't do that.'*	recognise that there is a conflict of interest for students who participate in assessment design and it is therefore important to follow a structure with clear pre-determined boundaries.
Best practice	• Transparency • Accessibility • Equity and inclusivity at the forefront • Testing skills, understanding and critical thinking – not memory	• Transparency • Accessibility • Equity and inclusivity at the forefront • Testing skills, understanding and critical thinking – not memory • Changing course-level learning outcomes, assessment strategies and approaches to marking • Additional training	• *'A variety of options that means I can select an assessment that will give me the best possible opportunity to demonstrate my knowledge as well as the application of that knowledge […]'* • *'An assessment that is accessible to everyone.'* • *'The ability to understand that not all of us are neurotypical and do not approach assessments in the same way. Each of us come to assessments, and understand assessments differently […]*	• *'It's about making it accessible, so everyone's got a clear idea about what they need to do in order to learn efficiently and effectively for them, because it's different for everyone.'* • *'Transparency is really, really important when you're trying to innovate or try to do something alternative because students aren't used to it. [...] I don't find it very compassionate to leave them in the dark strategically.'* • *'…a transparency with the students, with how that's*	• The underlying design and justification of assessments must be transparent. Both students and staff are keen to use assessments to promote learning by testing understanding rather than mechanical memorisation. A diverse assessment approach should offer a range of assessment types, choice and flexibility

			Students are not a static body, but made of a variety of individuals, who learn and process information wildly differently from one another.'	*going to be assessed and then a development of the skills to allow them then to to utilise that particular mode of assessment that you've chosen within the diverse assessments that you might have […]'*	without increasing the burden of assessment.
Challenges and key considerations	• Implications of a diverse assessment strategy • Workload • Impact of personal circumstances on assessments • Limits of co-creation	• Difficulty implementing diverse assessment strategy • Workload • Changing university culture and policy • Resources needed • Limits of co-creation	• *'It would be nice if we had a choice of what kind of assessment to take […] It would be nice if we had a choice as to whether we wanted to take an exam or do an assignment of coursework. To the extent that I do understand that it will be very difficult for the faculty to go around correcting a variety of assessments […]'* • *'[…] it seems a little bit insane to me that we have really highly achieving academics, running courses and making assessments but not reflecting on actually what that means.'*	• *'[…] if you're going to do diverse assessments, I think the risks are that you then employ assessments which are not necessarily appropriate for the skills that you want your students to develop.'* • *'[…] number of requirements on us from the regulatory side […] indirectly from the eruption side comparison to all the universities […] standing in the academic community […] legal side of things.'*	• Both students and staff were concerned that implementing a diverse assessment strategy would overall lead to more assessments, resulting in an assessment burden on students and a marking burden on staff. This may be mitigated by implementing a continuous assessment model that offers students a choice of assessment modalities.

Student data: Survey

Student participants (n = 54) from 19 departments returned completed surveys. The Medical School had the highest representation (n = 16), followed by the Department of Economics (n = 9). Among the respondents, 17 required reasonable adjustments in timed exams, and 11 accessed adjustments in written assessments (Appendix 3). The assessment formats encountered by students are detailed in Appendix 4.

Of the 54 student participants, 46 answered the multiple-choice questions about circumstances affecting assessment completion or submission. 57 per cent of these cited 'excessive workload', 48 per cent mentioned 'difficulty with time management', 43 per cent found the 'assessment challenging' and 41 per cent had 'external responsibilities such as family/caring commitments' (Appendix 5).

In free-text responses, students favoured assessments that prioritise deep understanding and critical thinking over memorisation. They emphasised that effort should be the primary factor influencing grades. While various assessment methods were mentioned, no clear preference emerged. Fair assessments that account for individual differences and potential disadvantages, while avoiding bias, were reported as important to many students. Additionally, assessments accommodating disability and neurodiversity were seen as improving equitable opportunities for success.

Student data: Focus groups

The small focus groups, although potentially vulnerable to selection bias **(**Stone *et al.,* 2023), provided richer data. Two focus groups (n = 3; n = 4) recruited students from the Medical School, Business School, Department of Economics, and Global Sustainable Development Faculty. Most of these participants favoured continuous assessment and coursework over end-of-year assessments and closed-book examinations. However, one student preferred having a dedicated time to focus on end-of-year assessment. When exploring the concept of diverse assessment, students characterised diverse assessment as a range of assessment modes that caters for the diversity of the student population.

'[…] assessment types and options which work for everyone, including those with extra needs or from different backgrounds.'

Student focus group member

A key finding was the identification of language as a major contributor to determining assessment performance and fairness. Several participants, who were international students (n = 4) and spoke English as a second language, reported that certain assessments unfairly advantaged native English speakers. Specifically, multiple-choice exams may employ intricate language that is more challenging to interpret for individuals with English as a second language.

'[…] in multiple-choice exams, specifically where I just felt like… why am I thinking about grammar in an exam which is about human biology?'

Student focus group member

Another participant argued that group work can be more challenging from a language and cultural perspective.

'[…] I was working with a group and they were all very silent. And suddenly I noticed that they had switched on the transcript in Microsoft Word…you don't know whether they are not contributing to the conversation or the discussion because they're uncomfortable with the language or because in some cultures it's simply not okay to disagree with somebody.'

Student focus group member

A consensus emerged that using diverse assessment has the potential to both provoke deeper learning and to ensure all students have equitable opportunity to demonstrate their learning based on their strengths and preferred assessment mode. Furthermore, the students agreed that a diverse assessment strategy should incorporate choice and flexibility to reduce the assessment burden.

'[…] it should be five different assessments of which the student can choose one or two.'

Student focus group member

However, students did express concerns that diverse assessments may increase the number of assessments. While all students felt that assessments should stimulate learning, they considered that the current design prioritised recall of factual knowledge over promoting and valuing depth of understanding. Students envisaged future assessments that should focus on considering the student 'learning journey' and the development of skills and knowledge that have long-term and future application beyond their studies. Finally, although students were enthusiastic about the concept of co-creation in assessment design, they expressed concerns regarding upholding academic integrity and that students lack knowledge of university assessment policy.

'The only thing that really counts is kind of the number that's put on at the end of it, and that annoys me because I would like assessments to be a part of my learning journey […]'

Student focus group member

'What we can actually do is make them [assessments] more appropriate for the future of that person and actually use assessment as a training opportunity as opposed to examination at the end of a course or periodic assessment; we can actually use it as a teaching tool as well. And I think we should be diversifying assessment beyond simply assessment, but also looking at an application of learning as opposed to an assessment of knowledge, while still retaining the assessment of knowledge.'

Student focus group member

Staff data: Semi-structured interviews

Staff members (n = 6) from different departments participated in semi-structured interviews. There was significant overlap (Table 1) between the views expressed by the staff and students regarding current assessment approaches and future directions, although the language and framing used by the two groups differed.

When exploring the definition of 'diverse assessment', interviewees emphasised that equitable opportunities should be provided in assessment, but several also highlighted that the concept of 'diverse assessment' should also be incorporated into teaching methods, provision of materials and overall course structure to promote equity and inclusivity. Offering students variability, choice and flexibility was perceived to enhance learning of transferrable skills and maintain motivation. However, the key function of assessments should be to promote learning as part of a broader 'learning journey'. Traditional closed-book exams were perceived by some as outdated as learning for them is often strategic and short-lived.

'[…] it means that there is not one particular cohort of students that is disadvantaged by the choice of diversity that you use for your assessment strategy.'

Staff interviewee

'Simple old old-school exams. Memorise this. Regurgitate it, because two hours after the exam, no one remembers anything they wrote in the paper. That's not promoting student learning. In my mind, I do a lot of work with rethinking assessment, and in my mind, I'd love to scrap exams.'

Staff interviewee

Some staff expressed concerns that use of diverse assessments can potentially lead to over-assessments of students and increase workload burden for staff. Pedagogically, revisiting and building on previous learning is highly effective and this also presents an opportunity to prevent over-assessment, retain an acceptable level of marking burden and improve feedback for students while employing a diverse portfolio of assessment modes.

'I get three weeks to mark, maybe 600 essays. Yep, I can't be spending more than 10 minutes per essay, and that includes feedback. Because otherwise I won't mark them in time. […] If you remove that burden, though, 600 essays and you space them out throughout the year, I'm now spending 20 minutes per essay. Which means that the standard of marking will improve […]'

Staff interviewee

Transparency of assessments and of marking criteria was considered 'best practice' to promote student confidence and to facilitate learning. Likewise, accessibility, reasonable adjustments and mitigation were important considerations for assessment design. In practice, assessments favour neurotypical, able-bodied, native English-speaking, technology-literate individuals with no caring responsibilities.

'[…] a transparency with the students, with how that's going to be assessed and then a development of the skills to allow them then to utilise that particular mode of assessment that you've chosen within the diverse assessments that you might have […]'

Staff interviewee

University politics and hierarchies were perceived to hinder change. Several interviewees discussed the challenge of 'inheriting' modules and assessments and facing difficulties in altering or updating content without impacting other linked modules. This further highlighted the need for course-level review of assessment strategies.

Staff expressed openness to involving students as co-creators in assessment design. However, there was a concern that for the co-creation to work effectively, this process should include a diverse group of students from a wide range of backgrounds and attainment levels. Although there was enthusiasm for the implementation of a diverse assessment strategy, staff recognised this would be difficult without a culture change.

Discussion

The views of students and staff were aligned, with both groups expressing the same concerns and hopes for the future of assessments. While students focused on the impact of change, staff framed their ideas around models of pedagogy and the practicalities of implementing change in assessment.

Perception of diverse and inclusive assessments

Students and staff characterised diverse assessment as a range of methodologies examining different pedagogic domains and skills, aligning with DeLuca and Lam's (2014) findings on assessment practices supporting learners. Diverse assessment should enhance equity by accounting for complex student needs, using reasonable adjustments and compassionate mitigation policies. Implementation should focus on flexibility and choice without increasing assessment numbers or marking burden (Tai *et al*., 2022). Students grouped diverse and inclusive assessments together, while staff differentiated between diversity and inclusivity. Both groups raised concerns about the transition period to a new assessment approach. Student co-creation in assessment design has been proposed (Bovill, 2012; Neary, 2010) but presents challenges in the UK's marketised higher education system. Respondents emphasised that assessments should contribute to a broader 'learning journey', aligning with Bloxham's (2007) argument on assessment-driven behaviours. Fischer *et al*. (2023) demonstrated that summative assessments initiate learning but may not significantly influence learning practices. Students advocated for assessment choice within modules, while staff favoured improved reasonable adjustments. This tension reflects ongoing discourse in educational literature (Lawrie *et al*., 2017; Waterfield and West, 2008) on balancing inclusive assessment design with practical implementation.

Diversification through optionality or adjustments

Students and some staff advocated for offering a choice of assessment types, aligning with research suggesting that this can increase student engagement and motivation (Kessels *et al*., 2024). However, standardising marking and ensuring equal attainment of learning outcomes is challenging with multiple assessment options.

Reasonable adjustments, mitigation and flexibility should level the playing field to enable all students to demonstrate the same learning outcomes. However, current adjustments are often seen as inadequate and difficult to access (Bain, 2023).

Offering pedagogically valid assessment choices that facilitate course-level learning outcomes is supported by Neil and Padden (2022), who argue that student preferences depend on background, subject area, personal reasons and previous experiences. This suggests that students may perform better with a range of assessment modalities. Greater flexibility with deadlines and humane mitigation policies are especially important for students with health, social and financial pressures. Research indicates that many students work out of financial necessity, which can create an inequitable environment favouring more privileged students (Dennis *et al*., 2018).

Disabled, neurodiverse and international students are often most disadvantaged by traditional assessments. Viewing assessments as part of a 'learning journey' that includes accessible teaching materials and reasonable adjustments may be the best equaliser. This aligns with the concept of 'assessment for inclusion' (Tai *et al*., 2022), which advocates assessments that do not disadvantage diverse students. Strategies like authentic assessment and programmatic assessment can improve fairness and inclusivity (Dawson, 2020; Gulikers *et al*., 2004; Tai *et al*., 2022).

Both students and staff wanted assessments to have real-world applications, moving away from memorisation-based models. They favoured assessments that test critical thinking and interpretation. While traditional closed-book exams and multiple-choice questions were seen as discriminatory, some research suggests closed-book tests can stimulate deep learning

(Heijne *et al*., 2008).

Optionality in assessments may be idealised but impractical to implement and standardise. Reasonable adjustments should be more accessible and tailored to individual needs. Current processes for obtaining adjustments are often lengthy and undignified, as highlighted by Kendall (2018). There is a strong argument for overhauling the system of reasonable adjustments and mitigations to provide equitable opportunities for all students. If assessments aim to teach skills and embrace diversity, this should be reflected in their design to ensure fairness (Aristotle, 1999).

Students and staff as a united force vs 'the infrastructure'

Students and staff acknowledged the challenges in implementing a diverse and inclusive assessment strategy, noting a tension between their perspectives and the academic ecosystem. Staff often feel constrained by practical limitations such as timetabling, room availability and cohort size, which affect assessment arrangements. Traditional reasonable adjustments have primarily focused on in-person examinations, leading to confusion about the most suitable adjustments for diverse assessments. This inconsistency raises the question of whether reasonable adjustments should be standardised or personalised. To improve this situation, departments require better guidance and support in designing assessments that facilitate equal opportunities. Literature suggests that while standardising some adjustments can help address common barriers, individual circumstances often necessitate personalised solutions. For example, Cardiff University advocates for a combination of standardised and individualised adjustments, such as providing electronic copies of lecture materials and extended library loans, to ensure effectiveness while maintaining academic standards (Cardiff University, 2025). This confirms the importance of a balanced approach to effectively support disadvantaged students in higher education.

University policies and bureaucratic procedures can hinder or delay the implementation of diverse assessment strategies. Staff expressed concerns about the invisible politics and hierarchies within the university that obstruct revisions to teaching and assessments. Many described feeling constrained by 'inherited modules' from previous professors, which limits their ability to innovate. Empowering staff, particularly module leads, to take control of their teaching and assessments is essential for fostering positive change.

Despite enthusiasm for a diverse assessment strategy, staff remain cautious about its implementation. Changing university culture and policy is challenging, and both students and staff may resist such changes. Research indicates that resistance to change in higher education often stems from faculty culture, resource allocation and leadership dynamics (Chandler, 2013). Successful change management requires strong role models and effective leadership, suggesting that meaningful progress is possible even within complex institutional cultures.

To facilitate the implementation of diverse assessment strategies, it is crucial to provide educators with clear definitions, examples and support for experimentation. Addressing concerns about grade inflation and ensuring alignment between assessment methods and learning outcomes will reassure educators that diverse assessments can maintain academic standards while promoting student success. Ultimately, empowering staff to manage their teaching and assessments can yield significant benefits, but it necessitates careful consideration of potential barriers and proactive measures to support both educators and students throughout the transition.

Both students and staff recognised the benefits of student co-creation in designing and trialling new assessments, although they acknowledged the associated challenges, including the importance of academic integrity and students' limited understanding of existing assessment policies. Staff shared similar concerns while emphasising the difficulty in recruiting students from diverse backgrounds, as their absence could perpetuate inequities.

Students identified a conflict of interest when involved in assessment design, fearing that staff might not be receptive to their ideas. Conversely, staff expressed a strong desire to better understand the student perspective, advocating for co-creation as a true partnership rather than a mere consultation process (Bevitt, 2015). Both groups acknowledged that students often lack knowledge of university rules and regulations. High-quality feedback was deemed essential by both students and staff, yet neither group was fully satisfied with the current feedback model. There is a shared desire for a culture shift that fosters co-creation and provides high-quality feedback to support learning while maintaining a work-life balance.

Best practice

Students and staff advocated for transparent assessments that emphasise knowledge application and critical thinking rather than rote memorisation. They asserted that for an assessment to be considered best practice, it must provide equitable opportunities for all students, taking into account diversity factors such as disability, neurodiversity, income, caring responsibilities and language barriers. Both groups – staff and students – expressed the need for elements of choice and flexibility, improved reasonable adjustments and mitigation strategies, while emphasising that a diverse assessment strategy should not lead to an increased assessment burden.

The discussion highlighted complexities in the implementation of choice within modules, stressing that diversification should occur at the course level and throughout the curriculum to avoid over-assessment. This perspective aligns with O'Neill and Padden's (2022) argument that educators need to understand students' assessment experiences across their programmes, suggesting a comprehensive approach that transcends individual modules. The recommendation to share examples within teaching and learning circles further supports a curriculum-wide strategy.

Using formative and summative assessments, along with clear marking criteria and detailed feedback, was seen as vital for building student confidence and motivation in preparation for the workforce. Tai *et al*. (2022) corroborate these findings, noting that students have varying assessment goals based on their individual circumstances. The proposed ideal diverse and inclusive assessment strategy is based on a **spiral curriculum** with constructive alignment, where learning outcomes are defined before teaching and assessments are designed (Mazouz and Crane, 2013). This approach involves establishing engaging course-level learning outcomes that are broken down into modules, allowing students to revisit knowledge and build skills. This method fosters deeper learning and enhances student confidence (Johnson, 2017). Each assessment should have a clear purpose in the learning journey and should focus on a manageable number of objectives.

Exploring assessment diversification at the course level rather than at the module level allows for the reuse of assessment modes, enabling students to practise new skills and build confidence without the risk of over-assessment or increased marking burdens.

Challenges and key considerations

The main challenges identified by staff and students were workload and equity in implementing a diverse assessment strategy. Concerns were raised about increased assessment burden for students and marking burden for staff, potentially turning assessments into a strategic exercise rather than an enriching experience.

To mitigate workload, a continuous assessment model with sensitive reasonable adjustments and course-level diversification is recommended. Careful consideration of choice implementation is necessary to ensure standardised marking and equal opportunities. Prioritising the learning journey helps ensure assessments have purpose.

The literature highlights student engagement and empowerment as key benefits of diverse assessment methods. While time and resources are perceived as barriers, studies suggest these may be more perceived than actual (Bevitt, 2015). Providing educators with examples and support can help overcome these barriers. Participants emphasised the importance of equitable assessments that improve accessibility and inclusivity.

As universities adapt to integrating AI into assessment strategies with a focus on critical thinking and practical application of knowledge, co-creation with students is particularly opportune as the impact of such potentially profound change must be confronted by both staff and students. Chan's AI Ecological Education Policy Framework (2023) addresses the implications of AI integration in academic settings. Key considerations for incorporating AI into assessment strategies include redesigning assessments, developing AI literacy programmes, creating opportunities for AI application, emphasising ethical considerations and collaborating with industry partners.

Strengths and limitations

Involving students as co-investigators emphasises the community of interest between students and academics in university life. We have therefore modelled the collaboration advocated in the recommendations for future action. Despite the small number of participants and our location in a single UK university, the methodology has harvested a significant body of rich data that can inform future research and practice.

Conclusions and recommendations

The primary finding of this study is the synergy between students and staff. Diverse assessment is perceived as a way of improving inclusivity, accessibility and equity. Staff were more likely to appreciate the distinction between diverse and inclusive assessments, and the impact this would have on implementing the ideal assessment strategy. The consequent debate about whether to include choice within module or course level or to focus on improving reasonable adjustments is complex. Based on the data, the study justifies a carefully thought-out approach that considers improving both aspects in course-level assessment design.

This study corroborates the vulnerability of students with disability, neurodiversity, language obstacles, caring responsibilities and financial hardship that could be ameliorated with the introduction of diversity in assessment. Students and staff feel that each assessment should have a purpose and contribute to the 'learning journey' without producing an unnecessary burden. A culture shift is necessary to implement more accessible teaching, improved reasonable adjustments, mitigation procedures and student co-creation. Obstructive hierarchies should be dissolved so staff can update their modules and assessments to better

reflect the current context and to support students more effectively.

As a result of the study, the authors make the following recommendations:

1. Assessment strategy and diversification: Assessment diversification should occur at course level (top-down), rather than within disjointed individual modules. This approach will prevent over-assessment of students and minimise the marking burden on staff.
2. Assessment optionality and adjustments: Assessment diversification by introducing optionality per assessment component should only be used after ensuring all options are equitable regarding difficulty index, time required for students to prepare and complete, having clear guidance and marking criteria, and assessing the same learning outcomes and skills. Most importantly, assessment optionality should not replace equity in assessment through the implementation of reasonable adjustments to cater for the diversity of student populations.
3. Consider the learning journey: Diverse assessments must be compassionate, begin with inclusive and accessible teaching complemented by improved access to support such as reasonable adjustments or mitigation, and end with assessment approaches that reflect the diverse requirements of our students, including factors such as language.
4. Real-world application: Assessments should have a purpose beyond factual recall of information. They should evaluate students' deep understanding, critical thinking and application of skills and prepare students for the world beyond academia.
5. Co-creation in assessment: Students should feel empowered to contribute to the development of an inclusive and diverse assessment strategy. However, co-creation can only lead to diversification if the student co-creators truly represent the views and experiences of the diverse student community and are supported by institutional frameworks to bring about change.
6. Further research: Future studies should recruit larger samples taken from a range of institutions worldwide. In the era of hyper-rapid technological change, there is an acute need for longitudinal studies to monitor progress and to assess whether the actions recommended in this report have been successfully implemented.

Declaration of interest statement

The authors declare that there is no conflict of interest.

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Appendix 1: Student focus group questions

A list of pre-agreed open-ended questions was used to guide the topic of conversation for student focus group interviews.

Table A1: Pre-agreed questions and prompts for the student focus groups.

Topic	Prompts
Introduction	• Please state your department and year of study. • Please give a short summary of your course's current assessment methods and structure.
General feelings towards assessment	• What do you feel when you hear the word assessment? • Do you think current assessments are fair? • What was fair/unfair about the assessments? • What do you feel the purpose of assessment is?

Understanding diverse assessment	What does ‘diverse assessments’ mean to you? • What has your experience with diverse assessments been? • Do you think diverse assessments benefit you as individual students? Why or why not?
Fairness	• What does the phrase inclusive assessment mean to you? Can you give any examples? • Do you think diverse assessments equate fairness? • What would make an assessment approach/strategy fair?
Current assessment approaches/ methods	• What has been your most enjoyable/beneficial assessment? • How do you feel about the current marking system? • What would be the criteria of a good marking rubric? • What do you feel about the timing of assessments on your course? Do continuous or end-of-year assessments have more benefit? • What are your thoughts on the current feedback system?
Inclusivity	• Do you think that current reasonable adjustments are sufficient to mitigate unfairness? (disability/ dyslexia/mitigating circumstances, etc.) • How comfortable do you feel about asking for support prior to and post assessments?
Benefits and challenges of diverse assessment	• What are the advantages/disadvantages of diverse assessments?
Ideal learning experience	• What do you enjoy about learning? • Ideal course structure? • Objectives from university? • What would you want to gain from assessment?
Implementation	• How do you think diversification of assessments can be achieved? • What resources would be required?

Appendix 2: Staff interview questions

A list of pre-agreed open-ended questions was used to guide the topic of conversation for staff interviews.

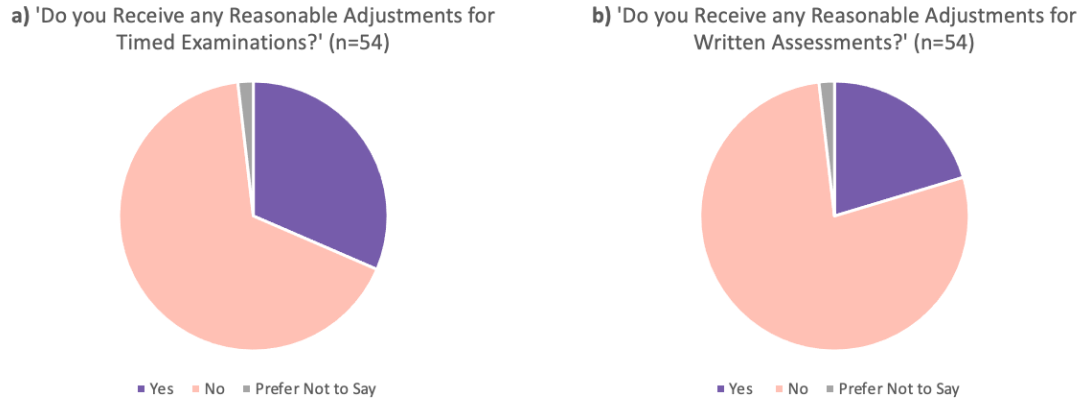
Table A2: Pre-agreed questions and prompts for the staff interviews.

Topic	**Prompt**
Understanding of diverse assessment	• Can you describe your understanding of what diverse assessment means? • Why are diverse assessments used? • What does the phrase inclusive assessment mean to you? Can you give any examples? • What does the phrase ‘learning from assessment’ mean to you? • What does ‘assessment strategy’ mean to you? What should be considered in a fair assessment strategy? • How can we ensure fairness of assessment approaches?
Assessment approaches	• What assessment approaches have you used? • What impact does it have for you as staff (design, delivery and marking)? • Which assessment approaches have in your view supported student learning? • What has the student response been to these approaches? • Which assessment approaches are more inclusive in your view?
Student impact	• What effect does use of diverse assessments have on student employability/learning/enjoyment?

Resources	What resources have you used to deliver new and diverse assessments? (Assessment guides, Marking approaches, Method of delivery, including online delivery, Mapping to skills) • How can we ensure that students are prepared for undertaking new assessments? • Are there any risks with the use of a diverse assessment strategy?
Assessment design	• Is there anything you feel that could be included/added to improve assessment design and delivery? • Suggestions for new assessment approaches? • What resources currently help staff to implement diverse assessments? • What factors make it challenging for staff to implement diverse assessments? • What further resources and training can help development and delivery of diverse assessments? • At what level do you think diversification of assessments should happen? Module? Year? Or course level?

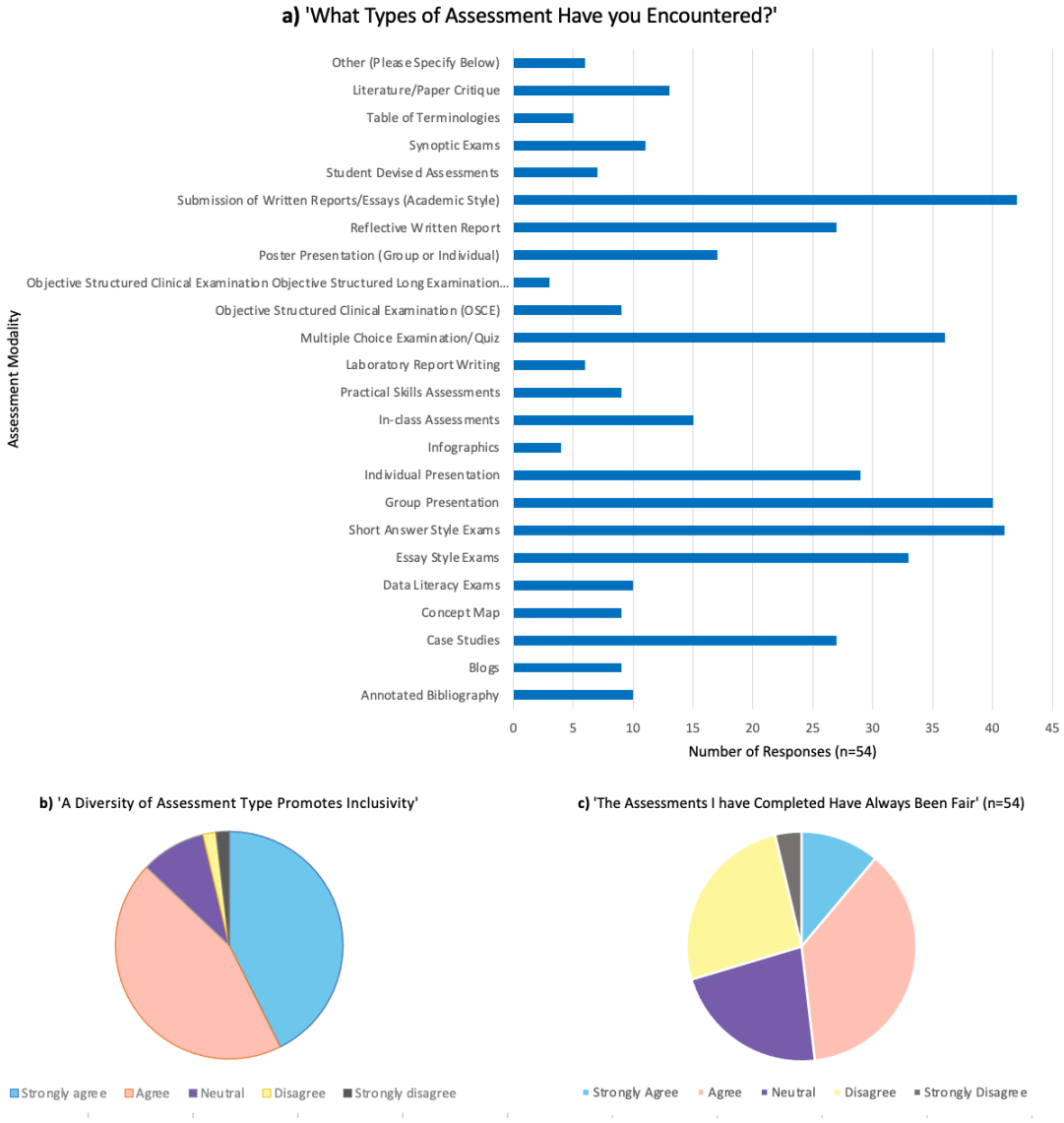
Appendix 3: Reasonable adjustments

Pie charts showing the proportion of students in the survey population who receive reasonable adjustments for: (a) timed examinations, (b) written assessments.



Appendix 4: Student survey data

Graphs showing data collected from the student survey: (a) types of assessments students have encountered, (b) agreement with the statement 'A diversity of assessment type promotes inclusivity', (c) agreement with the statement 'The assessments I have completed have always been fair'.



Appendix 5: Multiple-choice survey question responses

Graph showing students' responses to a multiple-choice survey question regarding circumstances affecting assessments.

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Glossary of terms

Assessment strategy: An assessment strategy is the co-ordinated, whole-course plan of assessment practices designed to align with clear learning outcomes, criteria and teaching activities. It guides when and how students are evaluated, supports meaningful feedback and development, and fosters deep learning rather than surface memorisation.

Spiral curriculum: An approach where key concepts are revisited multiple times, each encounter building on prior knowledge with increasing complexity and depth. Its aim is to foster long-term proficiency by progressively deepening understanding rather than covering topics just once.

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Breaking Barriers: A Comprehensive Study on the Pathways and Challenges Faced by First-Generation Students in Higher Education

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Abstract

This study explores the experiences of first-generation students at Warwick University, focusing on academic preparedness, financial barriers, social integration and mentorship support. The research specifically compares the experiences of students who were and were not part of the Warwick Scholars Programme, revealing that both groups faced similar challenges. Existing literature highlights challenges faced by first-generation students, including deficiencies in academic preparation, financial constraints and social isolation. Using a mixed-methods approach, this paper combines survey data (N = 24) with in-depth interviews (N = 4) to provide a comprehensive understanding of these issues. The findings reveal that both Warwick Scholars and non-Scholars experience similar levels of under-preparedness, despite pre-university interventions. Financial pressures significantly influence educational choices and contribute to family-driven stress. Social integration varies, with some students feeling isolated while others find community through extracurricular activities. Mentorship support is inconsistent, with some students benefitting from personal tutors and peer networks while others struggle to access adequate guidance. The study underscores the necessity for more inclusive and targeted support systems to address the multifaceted challenges faced by first-generation students. While the paper provides valuable insights, limitations include a small sample size, suggesting

the need for broader studies. Key recommendations include increasing counselling and skill-building workshops, expanding financial aid, and enhancing mentorship, guidance and career support to better support first-generation students.

Keywords: First-generation students in UK higher education, Academic preparedness of first-generation university students, Financial pressures on first-generation students, Social integration in higher education, Mentorship support for first-generation students, Warwick Scholars Programme.

Introduction

First-generation or 'First in Family' (FiF) students – typically defined as those whose parents or guardians have not attained a university-level degree (BA/BSc or higher) – represent a growing and important demographic in UK higher education (Adamecz-Völgyi *et al.*, 2020; Henderson *et al.*, 2020). More precisely, a young person is considered FiF if neither parent nor guardian had achieved a university degree by the time the student was aged 17 – namely, before their university application (Adamecz-Völgyi *et al.*, 2020). Much of the literature on first-generation experiences is US-centric, and UK-based research remains limited, particularly in terms of quantitative and institution-specific studies (Henderson *et al.*, 2020).

This study addresses that gap by examining the academic, financial and social experiences of **first-generation students** at a **UK Russell Group university**. It is situated at the University of Warwick and contributes to the growing body of UK-focused research on **Widening Participation** (WP). While grounded in Warwick's context, the findings and recommendations are relevant to other selective institutions with similar WP responsibilities.

The aim of this paper is to explore the lived experiences of first-generation students and offers actionable insights to enhance access to institutional support networks. A central focus of this research is the comparison between Warwick Scholars and non-Scholars. The **Warwick Scholars Programme** is a targeted WP initiative that supports students from underrepresented

backgrounds – including those from lower-income households, care-experienced or estranged backgrounds, and priority neighbourhoods (University of Warwick, 2025). In contrast, the non-Scholars in this study are also first-generation students but they did not receive support through this programme. Comparing these two groups allows for an evaluation of whether structured pre-university interventions translate into improved student outcomes and experiences.

First-generation students, regardless of programme participation, often face overlapping challenges such as financial constraints, unfamiliarity with university culture and limited access to guidance or resources (Pascarella *et al.*, 2004; Thomas, 2006). While institutional support services – such as academic advising and financial aid guidance – can improve outcomes (Wainwright and Watts, 2019), access to and effectiveness of such support vary significantly across student populations.

To investigate these issues, this study is guided by two overarching research questions:

1. How do first-generation students at the University of Warwick navigate academic, financial and social challenges in their university experience?
2. What roles do institutional support and mentorship programmes play in the academic success and well-being of first-generation students?

A **mixed-methods approach** was employed, combining quantitative survey data from 24 first-generation WP students (12 Warwick Scholars and 12 non-Scholars) and qualitative insights from semi-structured interviews (N = 4) to capture both breadth and depth. The survey included an additional six respondents who were not classified as WP students, but they are excluded from this comparative analysis. Participants were recruited through student networks, academic departments and WP initiatives, with eligibility based on self-identification as first-generation and confirmation of participation (or not) in the Warwick Scholars Programme. These research questions were further broken down into sub questions (see Table 1).

Table 1: Research questions

Research questions	Sub-questions	Data source

How do first-generation students at the University of Warwick navigate academic, financial and social challenges in their university experience?	1.1 How do first-generation Warwick Scholars perceive their academic preparedness compared to non-Scholars?	Survey (Likert scale): I felt academically prepared for university. Interview: Can you describe the academic skills and knowledge you acquired before starting university? How did this preparation affect your confidence in your academic abilities?
	1.2 What are the specific challenges faced by first-generation students in transitioning to university-level studies?	Survey (Likert scale): I have faced significant challenges as a first-generation student. Interview: What, if any, challenges have you faced that you feel are related to being a first-generation student? Which are the biggest challenges?

	1.3 To what extent do financial considerations influence education choices among first-generation students?	Survey (Likert scale): Financial considerations have significantly impacted my educational choices. Interview: How have financial considerations impacted your educational choices?
	1.4 How do family financial dynamics affect academic experiences of first-generation students at Warwick?	Survey (Likert scale): My family has provided substantial support for my higher education journey. Interview: In what ways has your family supported or influenced your journey in higher education?

	1.5 How do first-generation students perceive their sense of belonging at Warwick University?	Survey (Likert scale): I feel a strong sense of belonging within the university community. Interview: Can you share your experiences with social integration at university? Have you felt a sense of belonging within the academic community?
	1.6 What roles does cultural background play in shaping university experiences of first-generation students?	Survey: My cultural background has significantly influenced my university experience. Interviews: In what ways has your cultural background shaped your experiences at university?

What roles do institutional support and mentorship programmes play in the academic success and well-being of first-generation students?	2.1 How effective are mentorship programmes in supporting academic success among first-generation students?	Survey: I have had access to effective mentorship or peer support networks. Interview: Have you had access to mentorship or peer support networks? How have these influenced your academic journey?
	2.2 What are the perceptions of Warwick Scholars and non-Scholars regarding access to support services?	Survey: The academic support services at the university have met my needs. Interview: What types of academic support services have you utilised, and how effective have they been for you? How well do you think the university supports first-generation students?

The structure of this paper begins with a literature review on first-generation student experiences, followed by the presentation and analysis of the survey and interview findings. Through this research, I highlight both the barriers and opportunities encountered by first-generation students at Warwick,

contributing to the development of more inclusive and effective institutional support systems.

Literature review

This literature review explores the barriers faced by first-generation or 'First in Family' (FiF) students in higher education and examines how these challenges shape their academic engagement, social integration and access to institutional support. The review is organised into thematic subheadings, each providing a focused discussion on key issues identified in the literature and forming the basis upon which this study builds.

Academic preparedness and transition challenges

First-generation students often arrive at university with limited academic preparation and are more likely to be non-native English speakers, immigrants and financially independent (Bui, 2002; Jehangir, 2010, cited in Stebleton and Soria, 2013). This under-preparedness contributes to lower confidence and hesitancy in seeking help from faculty (Katrevich and Aruguete, 2017; Pascarella *et al.*, 2004), particularly when navigating academic expectations such as assignment requirements, academic writing structures and exam standards – areas that reflect a lack of **cultural capital** (Thomas, 2006). Consequently, the transition to university can be overwhelming, especially when institutional resources feel unfamiliar or inaccessible (Forsyth and Furlong, 2003, cited in Thomas, 2006; Stebleton and Soria, 2013). These challenges are further intensified for students who must work – often full-time – to meet living or tuition costs, limiting the time they can devote to study and academic engagement (Jehangir, 2010, cited in Stebleton and Soria, 2013).

Financial barriers and family dynamics

Financial pressures are a recurring barrier in the literature, with many first-generation students balancing academic demands with full-time employment

(Bui, 2002; Thomas, 2006). Family responsibilities can further constrain their engagement, particularly for those expected to support relatives or serve as role models for younger siblings (Jehangir, 2010, cited in Stebleton and Soria, 2013; Wainwright and Watts, 2019). Additionally, living off campus and time constraints from work or caregiving reduce opportunities for peer interaction and on-campus involvement (Pascarella *et al.*, 2004, cited in Stebleton and Soria, 2013). These factors collectively undermine academic focus and emotional support systems essential for student persistence (Thomas, 2006).

Social and cultural background

Beyond financial and academic barriers, first-generation students often face cultural dissonance as they navigate between home and university environments. The contrast between familial expectations and institutional norms can lead to identity fragmentation and a weakened sense of belonging (Oldfield, 2007; Rendón, 1992, cited in Stebleton and Soria, 2013). London (1989, cited in Stebleton and Soria, 2013) emphasises that these transitions are not only academic but also deeply social and cultural, often resulting in feelings of isolation, depression and loneliness (Lippincott and German, 2007, cited in Stebleton and Soria, 2013).

Peer support and integration are critical to student retention (Thomas, 2006), yet first-generation students – particularly those living at home or from diverse socio-cultural backgrounds – frequently struggle to integrate into university life. A mismatch between their home culture and university norms can hinder both academic engagement and social participation (Adamecz-Völgyi *et al.*, 2020; Forsyth and Furlong, 2003, cited in Thomas, 2006). These integration barriers highlight the limited social and cultural capital many first-generation students possess (Wainwright and Watts, 2019; Thomas, 2006), compounding their sense of disconnection in both settings.

Persistence and retention challenges

These combined challenges – academic under-preparation, financial strain and social isolation – contribute to lower persistence and graduation rates among first-generation students (Engle and Tinto, 2008, cited in Stebleton and Soria, 2013; Stebleton and Soria, 2013). Despite being well-positioned to benefit from high-impact educational practices such as learning communities and study abroad programmes, these students are less likely to participate due to limited awareness, time or access (Jehangir, 2010 cited in Stebleton and Soria, 2013; Kuh, 2008).

Institutional support and interventions

To counteract these disadvantages, targeted institutional interventions are vital. Academic bridging programmes, mentorship schemes, financial aid guidance and inclusive community-building efforts have shown promise in enhancing student engagement and retention (Bui, 2002; Katrevich and Aruguete, 2017). Increasing access to tailored support services and addressing practical barriers such as financial aid accessibility can further improve outcomes (Wainwright and Watts, 2019). These initiatives not only address structural inequalities but also foster a more supportive academic environment.

The literature illustrates that first-generation students face multifaceted challenges – academic, financial, cultural and emotional – that intersect and influence their higher-education experience. While much of the evidence comes from US-based research (e.g. Stebleton and Soria, 2013), the core themes resonate globally. However, there remains a notable gap in UK-specific studies exploring how these barriers manifest within British higher-education contexts. Addressing this gap is crucial for developing more inclusive support systems tailored to the needs of first-generation students in the UK.

Methodology and methods

Research approach and participants

This study adopted a concurrent mixed-methods design within a case-study framework, underpinned by an interpretivist paradigm. The interpretivist lens enabled an in-depth understanding of the lived experiences of first-generation students, and recognised the socially constructed nature of their academic transitions and challenges. The case-study approach provided a contextualised focus on a specific institution – the University of Warwick – allowing for a holistic examination of student experiences within this setting.

A total of 34 participants were involved: 14 Warwick Scholars and 20 non-Scholars, primarily undergraduates. Of these, 25 identified as female and 9 as male, leading to a gender imbalance; hence, gender-specific analysis was not pursued to preserve the integrity of comparative outcomes.

Students enrolled in the Warwick Scholars Programme meet eligibility criteria that reflect socio-economic disadvantage, making them an appropriate group for this study's focus on equity and access in higher education. The dual-method approach allowed the study to capture both broad trends and individual narratives across the two cohorts.

Qualitative component

Structured one-on-one face-to-face interviews were conducted with first-generation students, including Warwick Scholars and non-Scholars from diverse gender, ethnic and cultural backgrounds. Interview questions explored academic transitions, family dynamics, financial pressures and future aspirations. All interviews were audio-recorded and transcribed verbatim. A summary of interviewee demographics, including gender, Warwick Scholar status, education level and interview dates, is provided in Appendix A.

Thematic analysis was used to analyse the data. Four key narratives were reviewed closely, and recurrent themes were identified and descriptive codes assigned (e.g., 'Financial Impact' or 'Academic Preparedness and Confidence'). This coding process supported the generation of a thematic matrix which summarised key findings (see Appendix B).

Quantitative component

Quantitative data was collected via an online Qualtrics survey distributed to eligible participants. It included multiple-choice demographic questions, Likert-scale items assessing academic and social experiences, and an optional open-ended question for further insights. Survey data was anonymised and analysed using Qualtrics' descriptive statistics function.

Key demographic findings and patterns in the experiences of first-generation student are summarised in Appendices C and D.

Data collection and storage

Interview recordings were securely stored in a password-protected OneDrive folder, accessible only to the research team. After transcription and anonymisation, original recordings were deleted to protect participant confidentiality.

Informed consent was obtained from all participants. They were briefed on the study's aims and assured of anonymity and secure data handling. Ethical approval was granted by the University of Warwick's Ethics Committee, confirming adherence to protocols involving human participants.

Findings

This section integrates quantitative survey data (see Appendix D: Comparative survey results – Warwick Scholars vs non-Scholars) with qualitative interview insights (see Appendix B: Summary of interview findings) to explore the lived experiences of first-generation students at the University of Warwick. While the survey highlights broad patterns, interviews provide rich, contextual depth that reveals how these trends play out in individual lives.

Figure 1: Clustered bar chart regarding experiences of first-generation Warwick Scholars

Figure 2: Clustered bar chart regarding experiences of first-generation non-scholars

Academic preparation and confidence

Survey results (Appendix D) suggest comparable levels of perceived academic readiness between Warwick Scholars (36 per cent) and non-Scholars (42 per cent), indicating that scholarship status alone may not significantly influence preparedness. However, interview data (Appendix B, Table B1) uncovers important nuances. Some students described feeling underprepared due to limited support at school: *'My A-level experiences were challenging due to inadequate preparation from school.'* Others credited their schools with fostering independent learning: *My teachers encouraged me to explore topics on my own, which helped me adapt to university study.*

These contrasting perspectives suggest that confidence in navigating academic demands at university stems more from pre-university experiences than post-entry support. While Warwick Scholars receive additional academic resources, these alone do not always translate into higher self-assurance.

Challenges faced and financial impact

Over 80 per cent of both Scholars and non-Scholars reported facing significant challenges, including financial pressures, navigating university systems and juggling competing responsibilities (Appendix D). These findings were echoed in the interviews (Appendix B, Table B2), where students spoke candidly about the strain of managing work and study: *'I worked part-time, and it does interfere with my studies because it's difficult to manage my time well'.*

Financial constraints not only impacted daily life but also influenced course selection and long-term goals. For example, 64 per cent of Scholars and 50 per cent of non-Scholars reported that financial considerations shaped their academic decisions (Appendix D). Interviewees elaborated on how this impacted career planning: *'I chose my course partly because it leads to stable, well-paying jobs.'* Budgeting and financial management emerged as consistent

themes across both groups (Appendix B, Table B4): '*I plan and cook my meals each week to make sure I have enough for essentials.*'

Successes and achievements

Despite these challenges, students across both groups shared stories of resilience and accomplishment. Success was viewed not only through measurable outcomes – such as securing internships or scholarships – but also through personal growth and adaptation to university life (Appendix B, Table B3).

For instance, one student shared: '*I used to be very introverted, but joining societies really helped me come out of my shell*,' illustrating how engagement in extracurricular activities supported personal development. Others highlighted more tangible milestones: '*Securing a scholarship boosted my confidence and made me feel recognised.*' These varied definitions of success underline the importance of supporting both academic and personal development in holistic student experiences.

Family and social dynamics

Family played a dual role – providing emotional motivation but limited practical guidance. All participants reported a lack of **social capital** in their families, which hindered their ability to navigate university life effectively (Appendix B, Table B5). While family obligations sometimes conflicted with academic priorities, family support remained a powerful motivator: '*My parents had a big influence on me to pursue higher education as they have low-wage jobs and moved here to give me a better future*.'

However, the absence of cultural capital often left students feeling unprepared for the social and institutional norms of university, reinforcing the need for external support mechanisms.

Social and cultural integration

Experiences of social integration varied markedly. Only 18 per cent of Warwick Scholars reported a strong sense of belonging, compared to 50 per cent of non-Scholars (Appendix D), suggesting that institutional support systems may not fully meet the inclusion needs of all first-generation students.

Interview responses (Appendix B, Table B6) revealed how participation in extracurricular activities often promoted belonging: '*Joining societies fostered a sense of community.*' Cultural background also played a role. For some, multicultural exposure aided social connection: '*Coming from a multicultural background, I found it easy to relate to people from different cultures*.' Others, however, experienced a cultural disconnect that led to isolation: '*Coming from a small, non-diverse town, I sometimes feel like I can't fully fit in with certain groups because of cultural differences, which makes me feel a bit isolated.'* These findings underscore how both individual identity and institutional culture influence students' sense of inclusion.

Mentorship and academic support

Access to academic support services varied across groups. Around 50 per cent of both Scholars and non-Scholars expressed satisfaction with available support, with Scholars slightly lower at 45% (Appendix D). However, Warwick Scholars were more likely to benefit from structured mentorship programmes, while non-scholars often relied on peer networks or personal tutors (Appendix B, Table B7). One student explained: *'I didn't use the mentorship programme much because I found enough support among my peers.'* Yet several students noted barriers to access, such as low awareness or stigma around seeking help: '*I had a personal tutor, but it would have helped to have a peer mentor I could go to for advice.'* These insights suggest that increasing visibility and normalising the use of support resources could widen their reach, particularly for first-generation students unfamiliar with institutional systems.

Barriers and recommendations

Table 2: Descriptive statistics of support services access and perceived barriers (N = 12)

Group	Sought support services (%)	Needs met (Agree/ Strongly agree %)	Barriers to access (%)	Suggested improvements
Warwick Scholars	50	60	33	• Make support services more available and easier to access. • Advertise types of support service.
Non-Scholars	17	50	50	• Increase the visibility of support services through personal tutors. Online communications are often missed. • Make support services more aware and open, advertise them more.

Only 17 per cent of non-Scholars reported seeking formal support, compared to 50 per cent of Scholars, despite similar levels of satisfaction. This disparity indicates possible systemic barriers – such as lack of awareness, accessibility issues or stigma – that disproportionately affect non-Scholars. Even among Scholars, support was not universally sufficient.

To address these gaps, both groups recommended greater visibility, more proactive outreach and tailored resources. Scholars sought more structured guidance and skill-building opportunities, while non-Scholars emphasised the need for personal tutors to actively promote support services.

Student suggestions

Figure 3: Warwick Scholars' key suggestions in keywords

Figure 4: Non-Scholars' key suggestions in keywords

Across both groups, students made targeted recommendations for improvement, particularly in mentorship, financial support and career guidance.

Warwick Scholars highlighted the need for:

- additional counselling and skill-building workshops
- enhanced career support and outreach programmes
- greater recognition and awareness of social mobility initiatives
- increased financial support to ease educational and personal pressures.

Non-Scholars prioritised:

- better visibility of services, especially via personal tutors
- more inclusive academic, placement and extracurricular opportunities
- mentorship and clearer guidance from the first year onward
- a dedicated support group or online platform (e.g. LinkedIn) for job sharing.

These suggestions, illustrated in Figures 3 and 4, reflect a shared desire for more inclusive, visible and personalised support systems. Both Scholars and non-Scholars value mentorship, financial clarity and accessible career pathways. Incorporating these insights into future policy and programme development is essential for fostering a supportive environment for all first-generation students at the University of Warwick.

Future aspirations and resource needs

Students from both groups expressed aspirations for meaningful careers and upward mobility. However, unequal access to internships, networks and development opportunities was a persistent concern. As one student observed: '*More recognition for first-generation students and greater awareness of social mobility programmes would help*' (Appendix B, Table B9).

Students consistently called for structured, inclusive resources that target the distinct barriers they face. Career guidance, mentorship and community-building efforts were all highlighted as areas requiring focused investment. As one interviewee explained: '*Having access to peer mentoring programmes, like the Buddy Scheme, gave me direction and reassurance – more initiatives like this would make a real difference.*'

Discussion

In discussing the triangulation of data from interviews, surveys and literature reviews regarding first-generation students, we observe consistent themes across different types of data collection methods. These findings collectively highlight the challenges and needs of this student demographic, providing a richer understanding than any single method could offer. The findings are discussed thematically and interpreted in relation to the existing literature.

Academic preparation and confidence

1.1 Perceptions of academic preparedness

Participants' reflections revealed varying levels of academic readiness. While many first-generation students reported difficulties adjusting to university-level expectations, their perceptions of preparedness were shaped not only by academic skills but also by their confidence and access to prior information. This aligns with Bui (2002) and Jehangir (2010, cited in Stebleton and Soria, 2013), who noted that many first-generation students enter university less academically prepared due to **systemic disadvantages**. The internalisation of these gaps often results in hesitation to seek academic support, echoing Pascarella *et al.* (2004) and Katrevich and Aruguete (2017). In line with Thomas (2006), the unfamiliarity with academic structures highlights the influence of limited cultural capital.

1.2 Specific transition challenges

The transition to university was frequently described as overwhelming, particularly in the first year. This finding supports Forsyth and Furlong (2003, cited in Thomas, 2006) and Stebleton and Soria (2013), who argue that institutional processes can feel alienating for first-generation students unfamiliar with academic norms. The intensity of independent study, time management demands and academic writing standards often created a steep learning curve, especially for those balancing other responsibilities.

Financial barriers and family dynamics

1.3 Influence of financial considerations on educational choices

Financial pressures influenced many participants' academic decisions, such as module selection, commuting versus living on campus, and part-time work. This supports Thomas (2006) and Bui (2002), who emphasised the significant role of financial barriers in shaping student engagement. Consistent with Jehangir (2010, cited in Stebleton and Soria, 2013), several students reported working alongside studies, which reduced their ability to participate fully in academic and extracurricular opportunities.

1.4 Impact of family financial dynamics on academic experiences

Family financial circumstances often placed implicit or explicit pressure on students, influencing their emotional well-being and time management. Some students felt obligated to support their families financially or prioritise cost-saving decisions. These experiences align with Wainwright and Watts (2019) and Jehangir (2010, cited in Stebleton and Soria, 2013), who found that first-generation students often feel responsible for family well-being. Living off campus due to cost constraints also reduced access to peer networks, a dynamic highlighted by Pascarella *et al.* (2004, cited in Stebleton and Soria, 2013).

Social and cultural integration

1.5 Perceptions of belonging at Warwick University

Students' sense of belonging varied, with many reporting initial isolation followed by increased integration through societies or academic groups. Interestingly, non-Scholar participants often reported greater ease in forming peer connections, suggesting that structured support schemes may not always equate to stronger social integration. This partially contradicts assumptions in the literature that institutional support programmes directly improve

belonging (Kuh, 2008; Thomas, 2006). Instead, peer relationships and organic social encounters may play a more influential role.

1.6 Role of cultural background in university experiences

Cultural background played a significant role in shaping university experiences. Students from diverse or working-class families often described a sense of disconnection between home life and university culture. This cultural mismatch aligns with Rendón (1992, cited in Stebleton and Soria, 2013) and Oldfield (2007), who observed identity fragmentation among first-generation students. The literature suggests that this dissonance can lead to loneliness and affect persistence (Lippincott and German, 2007, cited in Stebleton and Soria, 2013), a trend reflected in the accounts of students who struggled to reconcile personal identity with institutional expectations.

Institutional support and mentorship

2.1 Effectiveness of mentorship programmes

Experiences with formal mentorship schemes were mixed. While some Warwick Scholars appreciated structured guidance, others found the programmes too generalised or disconnected from their specific needs. This echoes Katrevich and Aruguete (2017), who found that while interventions can improve engagement, their effectiveness depends on personalisation and relevance. Peer support and informal networks emerged as particularly impactful, supporting Thomas (2006), who emphasised the role of community in student retention.

2.2 Perceptions of access to support services

Accessing university support services was seen as inconsistent. Some students were unaware of available resources or felt intimidated by the process. This mirrors findings by Wainwright and Watts (2019), who noted that institutional support is often under-utilised due to visibility and accessibility issues. Despite positive feedback from users of these services, the findings suggest a

need for more proactive outreach and clearer signposting, particularly by personal tutors and academic departments.

Conclusion

This study explored the experiences of first-generation students at the University of Warwick, with a focus on both Warwick Scholars and non-Scholars. Drawing on both survey data and interviews, the research identified key challenges related to academic preparation, financial pressures, social and cultural integration, access to support services and career readiness. While Warwick Scholars generally reported greater engagement with structured services, both groups highlighted the need for more personalised and accessible support systems.

These findings reinforce existing literature, which highlights that first-generation students often experience educational disadvantage due to structural and cultural barriers (e.g. Bui, 2002; Jehangir, 2010). The results suggest that addressing these challenges requires a holistic, equity-focused approach that recognises the diversity and resilience of first-generation students. Universities must not only offer resources but also ensure these are visible, approachable and relevant to students' lived experiences.

Based on the findings, the following recommendations are proposed to enhance support for first-generation students:

- Enhance counselling and skill-building workshops

Expand access to counselling and practical workshops focused on academic skills, financial literacy and transitioning to university life.

- Improve financial aid

Increase the availability of scholarships, bursaries and emergency funds. Ensure transparent and proactive communication about financial aid to ease student stress and widen access.

- Strengthen mentorship and career support

Develop peer and alumni mentorship schemes tailored to first-generation needs. Introduce targeted career development opportunities, including networking events and job preparation workshops.

- Increase visibility and personalisation of support services

Train academic departments and personal tutors to better signpost services using accessible, student-friendly language. Offer more tailored support aligned with individual circumstances.

- Expand academic, social and extracurricular opportunities

Create more accessible placements, society involvement and inclusive events to help first-generation students build peer networks and a stronger sense of identity and belonging.

Future research should explore the intersectionality of students' identities (e.g. ethnicity, socio-economic background and religion, as well as the effectiveness of these recommendations once implemented. Further investigation into the role of digital tools in supporting first-generation students may also prove valuable.

Importantly, first-generation students are not a homogenous group. Their experiences are shaped by a range of intersecting identities and personal circumstances. By acknowledging this diversity and building on the unique strengths that first-generation students bring to higher education – such as resilience, adaptability and fresh perspectives – universities can create a more inclusive and dynamic academic community.

By implementing these strategies, universities can better support first-generation students and cultivate a more inclusive, supportive and socially mobile academic community.

Acknowledgements

As a first-generation university student, this research journey has been deeply enriched by the continuous support and encouragement from many people and institutions. This achievement is not just an individual accomplishment but a reflection of the collective effort and belief in my potential.

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I extend my heartfelt thanks to the Social Mobility Student Research Hub at the University of Warwick for providing the platform and resources that have significantly enriched my paper. The hub's dedication to bridging educational divides aligns perfectly with my own aspirations, reinforcing my commitment to using my research to positively impact society.

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Appendices

Appendix A: Table of interviewees

Table A1: Interviewees

Interviewee	Gender	Warwick Scholar? (YES/NO)	Level of education	Date of interview
Student 1	F	YES	UG	08/05/2024
Student 2	M	NO	UG	17/05/2024
Student 3	F	YES	UG	27/05/2024
Student 4	F	NO	UG	10/06/2024

Appendix B: Summary of interview findings with first-generation students

Table B1: Academic preparedness and confidence

Students	Summary
1	The individual's preparation for university was insufficient and affected their confidence in their academic abilities. The school they attended did not provide the necessary skills or knowledge required for university-level work, which made them feel unprepared and anxious about starting university. This lack of preparation also led to feelings of self-doubt and imposter syndrome as they felt out of place among their peers who seemed better prepared. However, their determination to succeed and the emotional support from their family helped them navigate these challenges and build their confidence over time.
2	The individual's preparation for university was adequate but not entirely sufficient, which affected their confidence in their academic abilities. They attended a state comprehensive school where they focused on their A-levels in mathematics, biology and chemistry. Despite having dedicated teachers who pushed them to aim high, they still felt underprepared for the independent learning and extensive reading required at university. The teaching style and level of academic rigour at university were significantly different from what they were used to, which initially led to a dip in their confidence. However, over time, they adjusted by seeking support from tutors, joining study groups and improving their study techniques, which gradually improved their confidence as they adapted to the new academic environment.

3	The individual's preparation for university was somewhat adequate, which positively affected their confidence in their academic abilities. Before starting university, they had acquired some academic skills such as referencing and essay writing from their history A-levels. These skills provided them with a solid foundation and boosted their confidence when handling university-level assignments that required similar skills. However, they still felt underprepared for the independent learning and extensive reading required at university. The teaching style and level of academic rigour at university were significantly different from what they were used to, which initially led to a dip in their confidence. Despite this, they gradually adjusted to the new academic environment and continued to develop their skills and knowledge throughout their time at university.
4	The individual's preparation for university primarily consisted of developing skills in time management and effective revision strategies through their A-level studies. These skills helped them manage the pressure of deadlines and exam preparation at university. However, they found that the method of revision at university differed from A-levels, as there were fewer past papers to practice with and lecturers often created their own questions. This difference initially posed a challenge, but the skills they acquired during their A-levels allowed them to adapt and continue to perform well academically.

Table B2: Challenges faced

Students	Summary
1	The individual faced several challenges as a first-generation student, including academic, financial, social and emotional difficulties. Academically: adapting to a rigorous academic environment was tough without prior experience or guidance, and writing essays required more time and effort than it seemed to take others. Financially: supporting themselves financially was challenging, and they were unable to secure a grant despite eligibility, adding to the financial burden. Additionally, commuting home every weekend to help their parents with work took up significant time, impacting their study schedule and social life. Socially: finding a sense of belonging was difficult, and while they attended events and joined societies, they often felt out of place. However, forming a close bond with a flatmate provided some social support.
2	The individual faced several challenges as a first-generation student, including navigating the university system without prior guidance, financial pressures and feeling out of place among peers with more familiarity with university culture and resources. The biggest challenge was managing the financial strain of university life, as balancing part-time work with academic commitments often left them exhausted and impacted their study time. Another major challenge was understanding and accessing available resources and support services, as they had to figure out everything on their own without a family background in higher education.

3	The individual faced several challenges as a first-generation student, including dealing with complex student finance forms, staying motivated to attend university despite not living on campus, and navigating the bureaucratic aspects of higher education without prior family experience. The biggest challenge was navigating the bureaucratic aspects of higher education, as it required them to figure out everything on their own without any prior guidance or experience.
4	The individual faced several challenges as a first-generation student, including a lack of support from their family within the university system, limited knowledge and advice compared to their peers, and fewer networking opportunities. They also mentioned that future career prospects might be more challenging for first-generation students due to a lack of parental understanding and networking. One of the biggest challenges they faced was the amount of content they had to remember and understand, and a personal challenge was asking for help, which they have struggled with throughout their academic career.

Table B3: Success and achievements

Students	Summary
1	The individual had several positive experiences at university, including being part of the Warwick Scholars Programme, which provided financial support and enhanced their skills in problem-solving, communication and organisational awareness. They also found success in undertaking their current research project, which aligned with their interests and provided valuable academic experience. Additionally, having a nice accommodation and friendly flatmates was a positive aspect of their university life.
2	The individual's significant successes at university include being awarded a scholarship, which boosted their confidence and relieved financial pressure, and participating in a summer internship programme, which provided practical experience and helped them build a professional network. These opportunities affirmed their academic and career aspirations and showed them that hard work and perseverance pay off.
3	The individual's significant successes at university include making friends, achieving good grades in their modules, becoming more independent and maintaining a healthy work-life balance. These accomplishments have helped them feel more confident in their abilities and more integrated into university life.
4	The individual's positive experience at university includes being able to come out of their shell and meet new people, which can be challenging for them as an introvert. By being more outgoing, they have been able to meet people from all walks of life.

Table B4: Financial impact

Students	Summary
1	Financial considerations have significantly impacted the individual's educational choices, as they accepted expensive university accommodation that consumed most of their maintenance loan, limiting their financial flexibility. They opted for accounting and finance courses with the aim of securing a stable job after graduation. Despite the high cost, they used their scholarship to study abroad, prioritising personal growth. Commuting home every weekend constrained their time on campus, reducing opportunities to engage in social activities. Financial stress is a constant presence for the individual at university, often distracting them from their studies. The time spent commuting home every weekend limits their ability to participate in weekend campus events and social activities. Cooking their meals is a budgeting strategy they employ to manage expenses.

2	Financial considerations have played a crucial role in the individual's educational choices, as they chose to attend a university that offers financial aid and scholarships. To manage costs, they opted to live in university accommodation with lower rent. Additionally, they often had to choose between part-time work and extracurricular activities, sometimes missing out on valuable experiences to ensure they could support themselves financially. Financial stress has always been present during their university experience, making it challenging to balance work and studies and sometimes affecting their academic performance. Limited funds also meant they had to be very careful with their budget, often missing out on social events and activities. However, financial aid and scholarships have been a lifeline, allowing them to focus more on their studies and less on financial worries.
3	Financial considerations have not significantly impacted the individual's educational choices yet because their chosen course is paid for by the university. Since they do not live on campus, they do not have to worry about accommodation costs, which has reduced financial stress. This has allowed them to focus more on their studies without the added pressure of financial burdens.

4	The individual has made financial considerations a priority in their educational choices by using a budget tracker to ensure they have enough money for food each week. They also decided to stay local for university, living close to home, which allows them to stock up on food from home. However, they regret joining a sports society due to the expenses associated with it. Overall, financial considerations have impacted their experiences at university by making them more mindful of their spending and limiting their participation in certain activities.

Table B5: Family and social dynamics

Students	Summary
1	The individual's family has been emotionally supportive, always encouraging them to pursue higher education. However, they are unable to provide financial support, making scholarships and student loans essential for the individual's education. As the eldest child, the individual has significant family responsibilities, including helping their parents with their work and caring for younger siblings. This often conflicts with their academic responsibilities, particularly during exam periods when they need to focus on their studies.
2	The individual's family has been incredibly supportive emotionally, always encouraging them to pursue their education and achieve their goals. Although the family couldn't provide financial support or academic advice, their belief in the individual's potential has been a constant source of motivation. They celebrate the individual's successes and provide a strong support system, reminding them of the importance of education and perseverance. As the eldest child, the individual has responsibilities at home, including helping with household chores and supporting their younger siblings with their schoolwork. These obligations sometimes make it challenging to focus entirely on their studies, especially during exam periods. However, the individual has learnt to manage their time effectively and prioritise their responsibilities to balance both family duties and academic commitments.

3	The individual's family has been very supportive throughout their higher-education journey, ensuring they are not too stressed and encouraging them to take breaks when needed. They also offer advice on various matters concerning university, such as maintaining a good work-life balance and planning their career. Their emotional support has been invaluable in helping the individual navigate the challenges of university life. The individual has no family obligations that may limit or hinder their academic career. This has allowed them to focus entirely on their studies and personal development without the added responsibilities that some students might face.
4	The individual's parents have had a significant influence on their pursuit of higher education, as they have low-wage jobs and moved to a new country to provide their child with a better education. They want their child to obtain a good, stable job, so they encouraged them to attend university. Family obligations impact the individual's academic life, as they come from an immigrant family and their parents often need their help, adding stress and extra tasks to their university work. Having to assist with the family's business sometimes means they cannot commit to social activities with friends in the late afternoon or evening.

Table B6: Social and cultural integration

Students	Summary
1	Social integration has been challenging for the individual, as they are placed among students from more privileged backgrounds. Their ethnic and cultural background sometimes makes it difficult to fit in, leaving them feeling stuck in the middle. Initially, the individual didn't feel a sense of belonging within the academic community. However, support from professors, their personal tutor and peers has gradually helped them feel more included, especially through group projects and discussions. While they still struggle with feelings of not fully belonging, they have found a supportive network on campus.

2	Social integration was challenging at first for the individual, particularly because they felt different from many of their peers who had more affluent backgrounds and familiarity with university life. Joining societies and clubs related to their interests helped them build a network of friends and feel more connected to the university community. Participating in group projects and study sessions also helped them integrate socially and academically. Initially, the individual struggled to feel a sense of belonging within the academic community. However, over time, they built relationships with lecturers and peers through group projects and class discussions. Joining academic societies and attending departmental events also helped them feel more connected. Now, they feel more confident in their place within the academic community and appreciate the diverse perspectives their peers bring. The individual's cultural background has significantly shaped their experiences at university. Coming from a working-class background has given them a unique perspective on many issues and made them more empathetic towards others facing similar challenges. Their cultural background has instilled a strong work ethic and resilience, which have been crucial in navigating the demands of university life. Additionally, being part of a minority group has made them more aware of the importance of diversity and inclusion, and they actively contribute to these conversations on campus.

3	Social integration has been somewhat limited for the individual because they do not live on campus. However, they have made friends and joined some societies, which has helped them feel part of the university community. They feel a sense of belonging within the academic community, especially through these social connections and participation in university activities. The individual's cultural background has made them seek out people from similar backgrounds more actively. They have joined South Asian societies and befriended people from their own culture to immerse themselves more in their cultural background. This has helped them feel more connected and supported at university, providing a sense of community and belonging.
4	As an introvert, the individual was initially terrified about going to university without knowing anyone. However, they decided to put themselves out there and joined societies, which helped them find good friends and feel a sense of belonging within the academic community. They believe that even if someone doesn't find their people in the first few weeks, they will eventually find them later. The individual's cultural background has expanded significantly since coming to university from a small, non-diverse town. They have met many people with different cultures due to the university's diversity, which has been interesting and unique. However, they still sometimes feel like they cannot fully merge into certain scenarios due to cultural differences.

Table B7: Mentorship and academic support

Students	Summary
1	The individual has had access to mentorship and peer support networks, which have significantly influenced their academic journey. They have a personal tutor who listens to their concerns and provides valuable advice and support. Additionally, they have participated in peer mentoring programmes such as the CoACH mentoring programme and the Buddy Scheme programme, where they were paired with an MBA mentor and a third-year student in their course, respectively. These experiences have been insightful and helpful, offering guidance and resources relevant to their academic journey. The support from their personal tutor has been crucial in staying motivated and seeking necessary resources. The peer support networks have been beneficial in terms of interacting with peers at different stages and gaining useful resources and feedback, helping them navigate university life more effectively. In terms of academic support services, the individual has utilised the following: • Math resilience workshop: Support in overcoming maths anxiety. • Essay writing support: Provided valuable feedback on essay structure and content, which was particularly effective during their foundation year. These academic support services have been effective for the individual.

2	The individual has been assigned a personal tutor for academic guidance and support. However, they feel that the mentorship could have been better if there was a peer to go to for assistance. In terms of academic support services, the individual has not had access to any. They believe that having access to such services could have been beneficial for their academic journey.
3	The individual has been assigned a personal tutor who checks up on them throughout the year. Having a personal tutor has been beneficial academically as their tutor offers guidance about current and upcoming years at university, such as what to expect in terms of workloads and how to spend their time effectively. This mentorship has provided valuable support and direction, helping them navigate university more successfully. In terms of academic support services, the individual has not attended any academic support sessions as they do not feel the need to. However, they are aware that these services are available and knowing that has been reassuring.
4	The individual has had access to mentorship through a personal tutor who is available to help and can be contacted via email. This has been comforting for them, knowing that they always have someone to support them throughout their university career. Additionally, lecturers are very willing to help if contacted via email. In terms of academic support services, there are many different programmes in place for struggling students. However, the individual has personally not needed to use these services.

Table B8: University support and resources

Students	Summary
1	The individual believes that while the university offers a range of support services, specific initiatives targeting first-generation students could be improved. They suggest that more targeted outreach and financial aid would be beneficial for this group. To better support first-generation students, the individual recommends expanding mentorship programmes to include more peer and alumni mentors who can share their experiences and advice. They also suggest implementing workshops on financial literacy, time management and mental health tailored for first-generation students. Increasing funding for scholarships and grants specifically for first-generation students would also alleviate financial stress.
2	The individual believes that the university offers support services that indirectly benefit first-generation students, such as the Warwick Scholars Programme. However, they feel that the awareness and accessibility of these resources could be improved. They suggest that more targeted outreach and communication about available resources would ensure that first-generation students can fully benefit from the support offered. To better support first-generation students, the individual recommends implementing more targeted outreach programmes to ensure that first-generation students are aware of available resources. They also suggest creating a dedicated support centre for first-generation students, which would provide a centralised location for resources and community building.

3	The individual believes that the university does a good job in supporting first-generation students. They mention that the university offers Widening Participation initiatives to provide extra support and guidance to first-generation students who are more likely to need assistance. Additionally, programmes like Realising Opportunities help A-level students who are first-generation and want to attend Russell Group universities, providing them with necessary support and resources. In terms of policy recommendations, the individual does not have any specific suggestions as they feel that the current support provided by the university has been sufficient for their needs.
4	The individual feels that the university has not adequately addressed the struggles faced by first-generation students compared to their non-first-generation peers. They mention that there is a lack of support and awareness regarding these issues. To better support first-generation students, the individual recommends implementing a dedicated first-generation student tutor or a specific person whom first-generation students can approach for help with any questions they may have. They also suggest creating programmes to enhance understanding of university studies, available courses and how these can contribute to future career advancements. Additionally, they propose increasing financial support for first-generation students to help alleviate some of their burdens.

Table B9: Future aspiration and reflection

Students	Summary
1	The individual aspires to work in the banking sector, potentially linking sustainability with finance. Their status as a first-generation student influences their aspirations by making them more determined to succeed despite the lack of a professional network or family experience in higher education. Additionally, they hope to assist in social policy to help create better support systems for students like them and advocate for educational equity. Looking back, the individual wishes they had known more about financial aid options and support services before starting university. They believe that early awareness of schemes and pathways for social mobility would have been beneficial. A comprehensive guide for first-generation students would have been incredibly helpful. They also mention that resources or workshops on time management and dealing with imposter syndrome would have been useful in navigating the challenges they faced.

2	The individual aspires to work in the field of engineering, specifically focusing on renewable energy solutions. Their status as a first-generation student has made them particularly aware of the importance of education and the opportunities it can provide. Their experience has instilled a strong sense of responsibility to give back to their community and support future first-generation students in achieving their goals. Looking back, the individual wishes they had access to a peer mentor from the very beginning, as it would have made the transition to university life smoother and less overwhelming. They also believe that more information about career planning and networking opportunities would have been beneficial in helping them prepare for life after graduation.
3	The individual aspires to have a stable job that utilises the degree they are working towards. Their status as a first-generation student has motivated them to work hard and make the most of the opportunities available to them, knowing that their achievements can pave the way for future generations in their family. Looking back, the individual wishes they had more guidance on handling finances and managing a good work-life balance with university. They believe that having access to these resources and advice early on would have made their transition to university smoother and less stressful.

4	The individual's future aspiration is to work in the cosmetics industry. As a first-generation student, they intend to look for a well-paying job that is located near their family. They believe that their status as a first-generation student may influence this aspiration because they feel they lack the necessary networking to secure a good internship for experience in this field. Therefore, they plan to start from the bottom to build their network. Looking back, the individual wishes they had known about all the internship opportunities that the university offers so they could apply for them to gain more experience and enhance their CV. They also regret not knowing about the Sutton Trust programme, which could have provided additional opportunities for learning and networking.

Appendix C: Demographic breakdown of survey participants from the University of Warwick

Table C1: Demographic breakdown of survey participants from the University of Warwick

Category	***Number of respondents***	***Percentage (%)***
WP student		
Yes	24	80%
No	6	20%
Warwick Scholars Programme		

Yes	12	50% (of WP respondents)
No	12	50% (of WP respondents)
First-generation status		
First-Generation	24	80%
Not First-Generation	6	20%
Level of study		
Undergraduate	26	87%
Postgraduate	4	13%
Gender		
Male	8	27%
Female	22	73%

Note: The survey included 30 respondents in total. Of these, 24 were first-generation WP students. Among these, 12 participated in the Warwick Scholars Programme, and 12 did not, either because they did not meet all eligibility criteria, were unaware of the programme, or chose not to participate. The remaining six respondents were not classified as WP students. Percentages in the Warwick Scholars Programme category are therefore calculated based on WP respondents only (N=24).

Appendix D: Comparative survey results: Warwick Scholars vs. non-Scholars

Table D1: Comparative survey results: Warwick Scholars vs non-Scholars

Statement	Response	Warwick Scholars (N = 12)	Non-Scholars (N = 12)
I felt academically prepared for university	Agree/Strongly Agree	36%	42%
	Neither agree nor disagree	19%	8%
	Disagree/Strongly Disagree	45%	50%
I have faced significant challenges as a first-generation student	Agree/Strongly Agree	82%	83%
	Neither agree nor disagree	0%	17%
	Disagree/Strongly Disagree	18%	0%
I have had significant successes or positive experiences at university	Agree/Strongly Agree	55%	83%
	Neither agree nor disagree	27%	17%
	Disagree/Strongly Disagree	18%	0%

Financial considerations have significantly impacted my educational choices	Agree/Strongly Agree	64%	50%
	Neither agree nor disagree	18%	8%
	Disagree/Strongly Disagree	18%	42%
My family has provided substantial financial support for my higher-education journey	Agree/Strongly Agree	9%	33%
	Neither agree nor disagree	18%	17%
	Disagree/Strongly Disagree	73%	50%
My family obligations have positively impacted my academic life	Agree/Strongly Agree	27%	33%
	Neither agree nor disagree	28%	42%
	Disagree/Strongly Disagree	45%	25%
My family obligations have negatively impacted my academic life	Agree/Strongly Agree	55%	33%

	Neither agree nor disagree	18%	17%
	Disagree/Strongly Disagree	27%	50%
I feel a strong sense of belonging within the university community	Agree/Strongly Agree	18%	50%
	Neither agree nor disagree	9%	17%
	Disagree/Strongly Disagree	73%	33%
I have had access to effective mentorship or peer support networks	Agree/Strongly Agree	45%	50%
	Neither agree nor disagree	37%	17%
	Disagree/Strongly Disagree	18%	33%
Balancing work commitments with studies has been challenging	Agree/Strongly Agree	64%	75%
	Neither agree nor disagree	27%	17%
	Disagree/Strongly Disagree	9%	8%

Note: Table D1 presents comparative survey results for WP students only (N=24), divided into Warwick Scholars (N=12) and non-Scholars (N=12). Percentages for each response category (Agree/Strongly Agree, Neither agree nor disagree, Disagree/Strongly Disagree) are calculated within each subgroup and sum to 100% for that subgroup. The six non-WP respondents are excluded from this comparison. Respondents indicated their level of agreement with the statements above, which served as the survey questions.

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Glossary

First-generation students (FiF): Students whose parents or guardians have not completed a university-level degree.

Warwick Scholars Programme: A programme at Warwick University providing support, skill development, and opportunities for students from underrepresented or disadvantage backgrounds.

UK Russell Group university: A group of 24 leading UK universities in the UK known for high research output, academic excellence, and selective admissions.

Widening Participation: Policies and initiatives aimed at increasing access to higher education for students from underrepresented or disadvantaged backgrounds

Mixed-methods approach: Research that combines quantitative data (e.g., surveys, statistics) and qualitative data (e.g., interviews) to gain a comprehensive understanding of a topic.

Cultural capital: The knowledge, skills, behaviour, and social assets that give individuals advantages in education and society, often influenced by family background and upbringing.

Social capital: The networks, relationships, and social connections that provide individuals with support, resources, and opportunities, often influencing education and career outcomes.

Systemic disadvantages: Structural inequalities or barriers within society and institutions that limit opportunities or outcomes for certain groups, often based on socioeconomic background, race, gender, or other factors.

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Britishness and the Politics of Exclusion

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Abstract

The persistent question of whether Britishness is under threat has dominated British politics, and yet exploration of the nature of Britishness and its societal context is seldom highlighted. This paper explores the nature of Britishness today via secondary data analysis of secondary qualitative sources, organised into three key sections. Examining a variety of academic theoretical and empirical research, it firstly explores the historical foundations of Britishness before examining the process of devolution and Brexit as two key case studies. This paper also extends and develops theory from Arthur Aughey's (2010) work. While the theory originally intended to analyse Englishness or English nationalism, this paper extends the theory's application to Britishness, emphasising its benefit in the field of British politics and related disciplines as an imperative analytical tool to enrich wider empirical and theoretical analysis. Ultimately, this paper posits that Britishness today is often used as a political tool, which is detrimentally based on and enforces the politics of exclusion. However, in recognising its paradoxical and multifaceted complexity, it is recognised that Britishness also contains inherent subjectivities as related to ideas of belonging. Overall, although not seeking to argue that Britishness is wholly bad, this paper hopes to highlight damaging discourses and events associated with the use and construction of Britishness as an exclusionary tool today.

Keywords: Britishness, Englishness, Arthur Aughey and British Nationalism, the Politics of Exclusion in Britain, Britishness as a Political Tool

Introduction

This paper accepts the basic definition of Britishness from work by Paul Ward (2004: 2), who states that it is flexible, and revolves around 'cultural and political identities associated with the existence of this [Britain] multi-national polity'. Ultimately, this paper argues that Britishness today can often present as an intangible set of elements based on – and enforcing – the politics of exclusion, and that it also has a multifaceted, paradoxical nature rooted within this type of politics. Importantly, this paper does not seek to argue that all aspects of Britishness are bad, as it recognises inherent subjectivities within Britishness. However, this paper also argues that while both subjective and academic epistemologies of Britishness have developed, due to the way that it is manipulated in political spheres in addition to its imperial history, Britishness as it exists today is often used as a deeply damaging and harmful exclusionary political tool.

As Ford (2008) powerfully points out, English and British nationalism are often conveyed via a paradoxical need to portray superiority versus a support for multicultural integration. As this paper will show in Sections I-III, while a complex debate, Britishness is often rooted in a deeply damaging sense of exclusion, which is both historical and ongoing. Section I explores its historical foundations as relating to colonialism and imperialism. Section II examines **devolution** and party politics as a key event that further revealed the nature of Britishness in addition to subjectivities within it, while also questioning who controls the boundaries of inclusion and exclusion regarding Britishness and British politics. Lastly, Section III explores Britishness via the polarising and othering instance of Brexit.

To argue the above points, this paper applies and extends arguments regarding the four types of 'anxieties' of absence, silence, anticipation and imitation, as outlined by Aughey (2010), which were initially intended to analyse *English* nationalism. Despite being an invaluable theoretical lens to explain the complexities of Englishness, at the time of writing, attempts to apply this aspect of his theory to also further explain the complexities of Britishness have remained surprisingly absent from the academic literature. In addition to providing more insight and context on Britishness as an almost intangible and

complex phenomenon, this paper seeks to address this gap in the literature, therefore conveying and elevating this 'anxieties' perspective as an extremely useful socio-analytical tool to examine and contextualise Britain today. To do this, this paper firstly outlines the key relevant aspects of Aughey's (2010) work that this paper will use in its arguments to justify its relevance and application. It will then analyse Britishness using various key historical events and periods as previously mentioned.

Considering the above aims of this paper, alongside challenging the gaps in the literature, this paper also hopes to identify and consequently challenge foundations of xenophobia, scapegoating and exclusion seen in the UK. At the time of writing, the politics of exclusion occurs in a myriad of ways, with the current most explicit aspect seen via the exclusionary rhetoric directed towards asylum seekers, disabled people and those with lower incomes. Currently, this type of enforced marginalisation can also be seen via attempts to decrease welfare spending in multiple areas by the current government. In highlighting multiple areas of exclusion within the definition of Britishness, this paper seeks to provide key insight to, and therefore also challenge, the underlying discourse behind much law, policy and politics in the United Kingdom.

Aughey, anxiety and injustice

Aughey's (2010) theoretical work is imperative in the analysis and evaluation of Britishness today. Although initially described by Aughey (2010) as one perspective to explain the complexities of English nationalism, in addition to **unionism** and ideas of an English Parliament, his work remains deeply invaluable in highlighting the complicated nature of Britishness. In relation to Aughey's (2010) work, some related definitions must firstly be established. While a key aim of this paper is to establish what Britishness is, in contrast, Englishness is often simply referred to as English nationalism. In turn, nationalism is described as 'a consciousness of national unity' (Heywood, 2017:164), and subsequently often involves ideas of constitutional government and potentially patriotism (Heywood, 2017). English nationalism

therefore relates to this solely in the context of England, while British nationalism or Britishness refers to all countries within the union. Interestingly, Aughey (2010) refutes the view that English nationalism is a movement, although he recognises that this may change, and instead defines it as a mood in line with his theoretical lens of 'anxieties'. Applying his work to Britishness is foundational in understanding current political, legal and policy contexts in the UK.

This paper refers to the four types of anxieties that Aughey (2010) argued are part of the mood of Englishness: absence, silence, anticipation and imitation. He argues that this is just one perspective that can explain the nature of English nationalism often described in academia and beyond. He also identifies multi-party politics and the Campaign for an English Parliament as two other key related perspectives that can be used to further examine Englishness (Aughey, 2010). While the latter two are interesting, this paper solely focuses on the 'anxieties' perspective as it deems it the most appropriate, although it does briefly explore related ideas while discussing devolution. Aughey (2010: 506) states that these four types of anxieties have a 'historical lineage' and exist due to the perception of a threat to the nation, but that they have also evolved over time alongside political events and globalisation. Ultimately, these anxieties are grounded in various forms of 'self-understanding' (Aughey, 2010: 507) and uncertainty, and thus have an element of subjectivity that this paper recognises in its application to Britishness. Overall, the anxieties are tied together via a theme of fear of the denial of Englishness as enforced by ongoing uncertainty of political identity in the face of threats to unity (Aughey, 2010). While Aughey (2010) does discuss Britishness, he focuses more on the increasing likelihood of the English to have concern with becoming trapped under an umbrella notion of Britishness, and thus losing their supposedly distinctive character. In some ways, Britishness is therefore seen as a threat to Englishness. Additionally, it is worth noting that this paper rejects Aughey's (2010) overall point mentioned above regarding the difference between a mood and a movement; the application of the prospect that Britishness is simply a 'mood' and not a

movement denies the possibility of accountability and systemic change in the face of its detrimental aspects.

The anxiety of absence refers to the fear that Englishness and the English people will cease to – or have ceased to – exist, or be erased by international and national communities (Aughey, 2010: 508–09). This paper applies this to Britishness regarding the historical foundations of Britishness, devolution and Brexit. The second anxiety, which Aughey (2010: 509–10) himself recognises has a major overlap with the first, is that of silence, which largely refers to a fear or suspicion of being silenced – for example, over **the English Question** and via 'conspiracies' that discredit or ignore Englishness. This paper applies this to Britishness in Sections I and II. The third anxiety is that of anticipation, regarding the supposed end of the United Kingdom, or unionism, which may result in the disappearance of Englishness, while bolstering the other nations (Aughey, 2010: 510–11). This paper applies this to Britishness briefly in the third section. Lastly, the fourth anxiety refers to imitation: the fear that the English have not asserted themselves in their own right, and that they have simply copied other nations in an attempt to be more likeable (Aughey, 2010: 511–12). This paper applies this to Britishness in Sections I and III. Overall, Aughey's (2010) work is invaluable in providing a helpful framework to analyse what Britishness means today.

Section I: The historical and imperial foundations of Britishness

The most important underpinning of Britishness today is undeniably its historical foundations. The Acts of the Union that resulted in the formation of Great Britain were passed in the relevant parliaments in 1707 and 1801, at the same time that British imperialism and the slave trade were in full effect. Both imperialism and Great Britain are intertwined via the monarchy – particularly via Queen Elizabeth I, who granted rights to the East India Company to begin colonial trade, and who also had a Scottish heir, which was arguably a key factor in the formation of the union (Ward, 2004). In Ward's (2004: 15) impressive work on Britishness, he states that the monarchy and imperialism

sought to 'perform the same function of forging Britishness'. Via analysis of the work of others such as P. J. Marshall (1995) and J. M. MacKenzie (2017), Ward argues that the link between imperialism and Britishness is clear via strong beliefs of superiority, exceptionality, loyalty to royalty and a strong sense of militarisation. Subsequently, he rightly points out that 'royal events were also imperial events' (Ward, 2004: 19), which inspired British popular support from each nation, and acted as a negative enforcement of Britishness. The monarchy remains a key aspect of British culture, and, in the words of Tom Nairn (2011: xii), 'royalty is an essential ingredient in maintaining the performance today' – the performance being the superiority of Britain. Applying this work, due to the history of the monarchy, royal events and tours tend to either be inherently imperialist or at least hint at imperialism. Ward's (2004) work is therefore key in portraying the continued links of imperialism and colonialism to the monarchy, and in conveying how both continue to persevere, via some events, to be elements of Britishness today.

Militarism and colonialism, as part of imperialism, are also argued to be inspired by irrational anxieties based on the fear of a threat (Nairn, 2011), which consequently relates to Aughey's (2010: 508–09) concept of the anxiety of absence regarding a fear of becoming less important in the international system. It is also in this sense that Britishness has been used to justify active destruction in the name of protection; the overwhelming element of British imperialism was justified partially on the basis of protecting various nations, and bolstering their existence, hence various leaders perceived imperialism as a form of protection and source of reassurance for their country. As Ward (2004) argues, each nation supported British imperialism to strengthen their own nation's interest. Evidently, this is based on an 'othering' process that inherently involves a sense of reassurance to the self via perceived control (Parvez, 2019), such as a leader to the nation. The imperialist foundations that bound, and continue to bind, Britain together therefore appear to have a dual nature when applying Aughey's (2010) work via application of the anxiety of absence; British imperialism was in some ways perceived as domestically 'comforting' in the face of a potential loss of control, yet also an evident

abomination that nonetheless resulted in the eventual breakdown of the British empire. The historical elements of militarism and colonialism, while utilising Aughey's (2004) work, are thus key in examining the roots of the politics of exclusion that underlie Britishness today.

While Ward (2004) only focuses on Britishness since 1870, this paper argues that analyses of imperialism before 1870 are also fundamental in examining the state of Britishness today. Many elements of current British culture are a result of the actions of the empire before 1870 (Sanghera, 2021). While perhaps it is unreasonable to expect Ward (2004) to cover the entirety of the imperial period in relation to Britishness, as Sathnam Sanghera (2021: 14) states in his wonderful yet harrowing book *Empireland*, '[…] our imperial past has had a […] profound effect on modern Britain'. He points out that the etymology of words, 'British' companies, foods, institutions and elements of popular culture were robbed from countries during the entire imperial period. Most of British culture is therefore unsettling in nature; it consists of an amalgamation of stolen elements as enforced by the monarchy and imperialism that have become so ingrained that they are perceived as unique when, due to British history, it is impossible to have a singular, wholly unique, geographically bound British culture. This raises questions regarding the extent to which Britishness today can be defined in its own right. It is also clear here that, again, Britishness today is, deludedly, based on the underlying politics of exclusion. Aughey's (2010) argument regarding the anxiety of imitation, the fear of copying another nation, therefore also seems ironic; imitation is inherently ingrained within British – and therefore English – culture. While culture is, by definition, not static, Britishness has clearly not evolved in its own right due to its colonial historical origins, which challenges both Britishness today and the future of Britishness.

Alongside British culture, the British political system that still operates is also intertwined with the monarchy, and has its historical roots during imperialist times, which again questions the level of authenticity within Britishness today. For instance, the previous British Prime Minister Benjamin Disraeli approved Queen Victoria's title as the Empress of India (Ward, 2004). Others have

suggested that imperialism was simply the result of 'gentlemanly capitalism' (Cain and Hopkins, 1987) within a free market liberal economy and laissez-faire economics that continue to operate today. However, this argument appears to justify atrocities as based on objective 'natural' market forces, and consequently questions the economic context behind Britishness.

Furthermore, the democratic, equal and just liberal society that supposedly exists in the United Kingdom today is underpinned by the 'fathers' of liberalism. As argued by Eileen Sullivan (1983), key liberal figures such as J. S. Mill believed that India, for example, was inferior. She points out that J. S. Mill also actively encouraged Britain's colonisation in India essentially under the premise of white saviourism and the belief that England's method of governance was supreme (Sullivan, 1983). Interestingly Sullivan's excellent paper also points out that unionism and thus Britishness itself was founded on the basis of imperialism, especially in relation to Ireland: the 1800 Act of Union inspired the belief that 'Ireland would remain part of the United Kingdom and in that sense they countenanced the change in her position and the extension of the Empire' (1983: 604). In this sense, Britishness is based on imperialism both internally and externally. Sullivan's (1983) superb analysis also portrays that the anxiety of absence relating to England underlies both liberal 'fathers'' above works. Overall, imperialism and the monarchy as foundations of Britishness have fuelled damaging exclusionary mindsets and beliefs regarding British national identity over the course of history. These will be further highlighted in the following sections; they are ingrained within everyday British life, from the economic system to various cultural aspects, as outlined by Sanghera (2021).

Section II: Devolution and Britishness

Moving from historical and imperial foundations, an emblematic case that can shed more light on Britishness today is devolution. As stimulated by the referendum in 1997, this refers to the transfer of power from Westminster to other countries in the United Kingdom in certain areas such as transport and education. As Vernon Bogdanor (2001) alludes, devolution and various

national unrest have been somewhat inevitable since the nineteenth century as regional differences increased. Overall, devolution has importantly highlighted that Britishness encompasses a complex range of identities and cultures, and that these should be recognised; the continuing complex elements of national subjectivities and debates around the independence and identities of the Welsh, Scottish, English and Northern Irish must be noted within discussions of Britishness. Yet the fact that England has strongly contested full Scottish independence, for example, has not only highlighted a sense of the anxiety of absence – fears that Britain will dissolve – but also again arguably portrays its underlying detrimental nature while forcing some people to be defined as British. The related case of Scotland also highlights the politics of exclusion; decisions of exclusion and inclusion are often used by Westminster at its own discretion. In many ways, devolution portrayed Britishness as a flexible, multifaceted – yet in some ways also as detrimental – phenomenon, encompassing multiple nations and perspectives.

Devolution also highlighted paradoxical elements as relating to a key phenomenon *within* Britishness that involves the Labour and the Conservative and Unionist parties. All parties have portrayed a strong sense of English exceptionalism (Richardson, 2008; Malik, 2022) – the idea that the English are in some way inherently superior. This evidently operates directly against the theoretical idea of unionism itself. This exceptionalism can arguably be seen in part via the Conservatives' coalition proposal of English Votes for English Laws (EVEL), which came into effect in 2015. MPs from devolved nations were able to vote on English legal matters in Westminster, but English MPs were not able to vote on legal matters regarding the devolved nations. EVEL was proposed in 2015 to address this. This was stimulated by the so-called English Question, also known as the West-Lothian Question, which questions the above issue that EVEL sought to address. This was a defensive attempt at, as Robert Hazell (2006:4) succinctly puts it, 'giving England a stronger political voice; and devolving power within England'. However, in some ways, EVEL encouraged the centralisation of power and dominance by Westminster that devolution sought to challenge. Although suspended in 2021, some – such as

Nicola Sturgeon from the Scottish National Party – argued that it unfairly favoured England while negatively affecting other devolved nations in areas such as spending, specifically targeting Scotland after the independence referendum (Sturgeon, 2015). Sturgeon and others also pointed out that it was difficult to determine what counted as a solely English issue (Gover and Kenny, 2015), meaning that EVEL carried a worrying opportunity for English superiority and dominance. It also highlighted the paradoxical yet continual tension between calls for unionism versus English superiority and national divisions involved within Britishness. The trend of English exceptionalism that is continually portrayed overall by Westminster, also via the generally **quasi-federal system**, again highlights some detrimental and paradoxical strands within Britishness today. Therefore, exploring devolution and related contexts, including English exceptionalism, continues to portray worrying aspects and tensions within Britishness as related to the politics of exclusion.

Interestingly, the above points support Aughey's (2010) *original* argument regarding Englishness and the anxieties of absence and silence; beliefs in English exceptionalism shown via EVEL can be seen as an attempt to ameliorate fears of the disappearance of Englishness, both politically and culturally. Pushing Aughey's (2010) work further beyond Englishness, his theory is also consistently implicit in the literature on devolution and on the 'crisis' of Britishness. The perceived 'crisis' is partially due to a range of discourses and events, including devolution, supposedly challenging Britishness or unionism (Ward, 2009; Keating, 2010). This crisis discourse has included fears of British absence and silence both internationally and domestically, and tends to be overblown (*The Economist*, 2017). However, the 'crisis' of Britishness discourse is also a further example of the perseverance of the anxiety of absence, arguably with its foundations in imperialist times. Here, overall, Aughey's (2010) work is deeply useful as an analytical tool to understand the complexity of Britishness today, especially in the context of devolution.

Section III: Brexit and Britishness

As another key political event related to uncertainty and polarisation in Britain, Brexit has highlighted major political strands and elements of Britishness today. It has also again portrayed how Britishness is often based on – and used to enforce – the politics of exclusion. This is further supported by application of the anxieties outlined by Aughey (2010), particularly the anxieties of absence and imitation as both relate to the fear of losing British identity within the European Union. This was powerfully implied by Dr El-Enany (2017: no pagination): 'The terms on which the EU referendum debate took place are symptomatic of a Britain struggling to conceive of its place in the world post-Empire.' As seen earlier, and due to its inherent foundations regarding the politics of exclusion, Britishness has often been defined by what it is *not*. There has been a detrimental form of othering historically, which has continued and can clearly be seen during and after the 2016 Brexit referendum.

Domestically, this was largely seen via the type of discourse used surrounding the referendum, which Rick Bowler (2017) argued by showing how the theory of numbers – which refers to the use of numbers and statistics to evoke an emotional response – was utilised in political discourse to define those who supposedly did not belong in campaigns for the 'leave' vote. Bowler (2017) persuasively argues that this is partially how British racism is predominantly displayed within the political sphere regarding Brexit – the United Nations has also pointed to the fact that British politicians have been to blame for the rise in racial and religiously based hate crime after Brexit (Butler, 2016). This can be seen via the – ongoing – behaviour of multiple key political figures such as Nigel Farage (Butler, 2016). Britishness today is thus often also underpinned by a consequent implication of whiteness, at the very least implied by some of the political elites and key figures involved in the EU referendum. Whiteness is often built upon a degree of comfort that many are reluctant to acknowledge, as highlighted by Robin DiAngelo's (2018) arguments regarding the notion of white fragility. This again highlights how perceived elements of Britishness, such as whiteness, are naively clung to by some individuals in the face of the anxiety of absence.

To further explain the element of othering involved, Aughey's (2010) work must again be applied. As seen by Dr El-Enany's (2017) quote above, the Brexit referendum caused a widespread, massive sense of uncertainty. The classically British principle of parliamentary sovereignty and the proud welfare pillar of the NHS were utilised in the face of the fear of the unknown and potential loss of a strong British identity. This can be seen via previous Prime Minister Theresa May's attempts to unite Britain in the face of polarisation, as hinted at by the work of Judi Atkins (2021). However, Atkins has argued that May's attempts to unite Britain were primarily directed at leave voters while excluding remainers, thus also portraying elements and boundaries of exclusion of Britishness within Britain. Furthermore, the split vote also arguably portrayed the fragility of Britishness, which is a common trope echoed or at least implied in some of the literature on Britishness, and sometimes utilised within the 'crisis of Britishness' rhetoric, as portrayed by Alex Niven (2021) for instance. Therefore, Brexit has highlighted again how Britishness can be utilised by both individuals and nations on the basis of otherness and exclusion, often in the face of fear or anxiety. However, this paper rejects that this foundation is a new evolution of Britishness, as seen via previous points, as this has existed since imperial times.

Brexit highlighted further the deeply multifaceted nature of Britishness, which has again conveyed the paradoxical, complex nature of Britishness itself. Brexit stimulated many different discussions on nationality, and thus identity, while also highlighting and questioning the rights of British and non-British nationals overseas (Benson *et al.*, 2022; Wright, 2020). Brexit highlighted definitions of Britishness as being both bound by nationality and bound by subjectivity; data has shown that subjective feelings of Europeanness compared to Britishness have been declining since 2007, despite 48 per cent voting to remain European (Batel and Devine-Wright, 2018). The vote result itself highlighted how divided the British public was; as Sales (2012) argues, tensions between 'Remainers' and 'Leavers' lie within the concept of the nation-state, and are based on the feeling of belonging. As also seen in the previous section, Britishness encompasses a variety of identities, of which

Sales (2012) argues a main conflict that the Britishness agenda has highlighted is between being Muslim and being British. As also hinted at by Sales (2012), the agenda of Britishness changes with each major political change, and events such as 9/11 and Brexit have placed this unnecessary contention on the agenda. The agenda of, and therefore epistemologies of, Britishness therefore consistently evolves due to its subjective, identity-based aspects, which somewhat clashes with its exclusionary foundations.

Furthermore, as Ward (2004:4) interestingly states, 'the frequent intermingling of different people from within and without the United Kingdom has also enforced a necessity for multiple identities'. Diversity and multiculturalism are inherent aspects of Britishness both historically and currently, yet they are often wrongly posed as antithetical to Britishness and as a threat, as also partially seen in the previous section. Multiculturalism as a term and policy approach became more popular post-1945, when after World War II, Britain invited citizens from previous colonies, including the Windrush generation, to help rebuild the economy. Britishness inherently contains aspects of movement and diversity, the former of which is especially overlooked. Britishness, and how one defines it, can be based on individuals' path of, or lack of, migration and the history behind that. Yet definitions of Britishness cannot be entirely objectively defined or controlled, despite the English state's shameful actions while operating within a hostile environment, as seen in part via the Windrush scandal, considering its evident links to subjective identity, complicated notions of belonging and its roots in imperial history. Overall, fundamentally Brexit portrayed again how Britishness today is consistently used to enhance the politics of exclusion, enforcing a mindset that causes harm to those who are deemed as not 'belonging' or not British.

These complex aspects of subjectivity in this case lead to Aughey's (2010) work. His analysis of anxieties is again deeply useful to analyse Brexit and Britishness, specifically regarding the anxiety of absence. This can be applied in two key ways: some feared the end of the United Kingdom's involvement in the European Union, while others feared the continued involvement in it. Brexit therefore built upon epistemologies of what it meant to be British;

Bowler (2017) argued that Brexit was symbolic of a racist Britain, portraying a fear of multiculturalism and intense xenophobia stimulated by ethnic, racial and citizenship-related supposed boundaries. Consequently, a survey by Michaela Benson *et al*. (2022) found that some feel embarrassed to be British, with the co-lead researcher Benson stating, 'it [Brexit] has brought deep transformations to the lives of British citizens in the EU and EEA' (quoted in Henley, 2022: no pagination). This is again reflective of differing personal epistemologies regarding Britishness, which is another factor in its complexity. Moreover, the survey also found that others were angered by their lack of free movement (Benson *et al*., 2022), again pointing to the facet of migration within Britishness.

In relation to Aughey's (2010) work, Brexit has also further encouraged a fear of absence; McDermid *et al*. (2021) has stated that Scottish people were strongly advised to reject independence in order to remain in the EU. In hindsight, it could therefore be suggested that the result of the Brexit referendum has been a further stimulant for Scottish independence and thus a rejection of the imitation of England, although admittedly there is mixed evidence to suggest this (Curtice, 2021). As also hinted in the above section, unionism and fears of its erosion is therefore also a deeply vital point to explore regarding Britishness. Aughey's (2010) work on the anxiety of anticipation, and thus the break-up of unionism, can also help analyse the potential future of Britishness. For instance, it could be asked how the anxiety of anticipation of the union breaking up directs voting behaviours and influences attitudes towards Britishness. Overall, Brexit and related factors again undeniably convey that Britishness today contains various levels of subjectivity while largely being based on and enforcing the politics of exclusion.

Conclusion

Overall, this paper has sought to highlight what Britishness means today. In order to do this, this paper has also applied the deeply influential work of Aughey (2010) to Britishness, which was specifically to relate to his theoretical

analysis of the four different types of anxieties to analyse Englishness. This paper has sought to encourage further application of Aughey's (2010) work to Britishness, as it provides an invaluable lens to support more nuanced and developed understandings of Britishness.

To conclude, Britishness has a deeply paradoxical and complex nature. This paper has highlighted this by exploring various historical and political events and periods – imperialism, devolution and Brexit – to focus analysis. Within this, this paper has highlighted the ways that Britishness is often used as a tool that is derived from and enforces the politics of exclusion. Importantly, part of its complex nature is the fact that there is a subjective element, which also makes it difficult to state that Britishness is wholly negative precisely because it is subjective. Ultimately, especially considering the current political climate in the UK and internationally, this paper has sought to highlight and challenge the damaging use of 'Britishness' as a political tool that underlies much of the recent and current political discourse in the United Kingdom.

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Glossary

Unionism: This relates to the theory that the United Kingdom and Northern Ireland should remain unified.

Devolution: The sharing or transfer of power or certain powers to 'lower' levels of government or to other governmental bodies. In the UK, this often

refers to Westminster sharing some powers with both local government and Wales, Scotland and Northern Ireland. This therefore challenges centralisation, where power is concentrated in one area.

Quasi-federal: The UK is often referred to as having quasi-federal status due to devolution. A federalism refers to a system of government whereby power is devolved. Due to the almost unitary status of Westminster or parliamentary sovereignty (essentially the idea that Parliament is supreme over other bodies) combined with devolution, the UK is therefore quasi-federal as it has both aspects.

The English Question: Also known as the West-Lothian Question, this refers to whether Members of Parliament from other parts of the UK should be able to vote on matters that only concern England.

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Awareness, Knowledge and Practice of Female Zayed University Students Regarding Folate and Folic Acid

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Abstract

Adequate and timely folic acid intake can prevent the development of most Neural Tube Defects (NTDs) during pregnancy. However, up-to-date information on how much childbearing-age women are informed regarding this is limited in the United Arab Emirates. This study evaluated awareness and knowledge level of folate and folic acid (FA), along with FA supplement intake among female university students. It also assessed major demographic factors associated with knowledge of folate and with FA supplement usage, as well as examining participants' risk level of inadequate folate intake. Of 239 female Zayed university students who completed the questionnaire, 63.2 per cent were aware of folate, and 44.8 per cent had good knowledge, but most (77 per cent) never took FA supplements consistently although the majority of the participants (38.5 per cent) were at higher risk of inadequate folate intake. Health science specialisation, history of folate deficiency or anaemia, and married or divorced marital status were associated with knowledge of folate/FA. Married/divorced marital status and history of folate deficiency or anaemia were also strongly correlated with FA supplement intake. However, pregnancy experience was not correlated with any of them. These results indicate a substantial gap in young women's knowledge and FA supplementation. Therefore, effective education programmes are required to increase knowledge and promote folate-rich food consumption and FA intake.

Keywords: Dietary folate intake among undergraduates, awareness and knowledge of folate, folic acid supplementation among female students,

demographic factors and knowledge of folate, demographic factors and folic acid supplementation, female university students and Vitamin B9

Introduction

Neural tube defects (NTDs), like spina bifida and anencephaly, are among the common **congenital disorders** affecting the development of the spine and brain that result in early death or lifelong disability for a child (Cordero *et al*., 2015). However, the occurrence of most NTDs can be prevented if women consume adequate **folic acid** (FA) and dietary **folate** prior to and during pregnancy (Botto *et al*., 1999).

Folate is the generic term for vitamin B9 that encompasses both natural (dietary) folates found in foods and the synthetic form, FA, which is primarily used in food fortification and supplementation (Berry *et al.,* 2010; Smith *et al.,* 2008; Smith, 2023). Dietary folates occur naturally in a reduced, **polyglutamate** form. Before absorption, these are converted into **monoglutamate** forms in the intestine and transported to the liver, where they are reconverted to polyglutamates for storage or transformed into 5-methyltetrahydrofolate (5-methyl-THF) (McNulty, 2024). In contrast, FA exists in a fully oxidised, inactive monoglutamate form that can be easily absorbed in the intestine. However, since the biologically active folate involved in DNA synthesis and red blood cell production is reduced THF derivatives, typically present as polyglutamates (Smith *et al.,* 2008), FA undergoes sequential reduction to dihydrofolate and then to tetrahydrofolate (THF). The produced THF is subsequently metabolised into intermediates that lead to the formation of 5-methyl-THF – the principal active form circulating in blood and supporting cellular metabolism (Scaglione and Panzavolta, 2014; Smith *et al.,* 2008). Thus, folate deficiency and FA deficiency are used interchangeably to refer to insufficient availability of folate in the body.

Generally, FA has a substantially higher bioavailability than the natural (dietary) folates, being rapidly absorbed across the intestine (Smith *et al*., 2008), and is more stable to degradation on cooking, making it preferable

for supplementation than the other folate forms.

Both dietary folate and FA, collectively referred to as folate, are used for red blood cell (RBC) and DNA synthesis in our bodies, and are essential for the development of neural tubes during the early stage of pregnancy (CDC, 2022; Smith *et al*., 2008). Inadequate folate intake can cause many health issues, including macrocytic anaemia and leukopenia, particularly due to impaired RBC formation, and risk of cardiovascular disease, cognitive dysfunction and liver disease associated with its DNA methylation/synthesis role (Yang *et al*., 2024). Also, folate status in the body is being linked to a broader range of clinical outcomes, including stroke, neurodevelopmental disorders, childhood leukaemia and lipid metabolism (Baddam *et al*., 2025). Besides this, folate deficiency in women is an important cause of NTDs in offspring, which are the second most common birth defects in humans (Wang *et al*., 2023). The incidence of NTDs is 0.5 to 5 per 1000 births (Wang *et al*., 2023), with 260,100 new NTDs cases in 2015 globally, of which 75 per cent (117,900) caused under-five mortality (Martinez *et al*., 2023), making the problem a critical issue that requires effective interventions.

Effective interventions such as mandatory food fortification and adequate FA supplement intake can help to significantly reduce the incidence of folate-deficiency-associated NTDs. Worldwide, 63 countries, including most countries in Latin America and Australasia, have adopted a mandatory policy for fortification of wheat flour, maize flour and/or rice with FA, although over 100 countries, including the majority of Europe, Asia and African countries had yet to implement the mandatory fortification policy in 2020 (Kancherla *et al*., 2022). The United Arab Emirates (UAE) also has not implemented a mandatory fortification policy with FA yet, although there is a voluntary fortification for wheat flour (Food Fortification Initiative, n.d.).

Effective and sufficient FA supplement intake can reduce the development of NTDs by 72 per cent and their recurrence in future pregnancies by 68 per cent (Bhutta *et al*., 2013). The World Health Organization (WHO) recommends that women take 400μg FA daily starting from before

pregnancy until they are 12 weeks pregnant (World Health Organization, 2023). Various countries also have recommended 400µg daily FA intake from supplements for all childbearing-age women in addition to dietary folate intake (CDC, 2022; de Rosset *et al*., 2009; Kim *et al*., 2018). Regardless of this effort, a wide range of folate deficiency is still observed worldwide. Based on a systematic review of all nationally representative surveys that reported folate deficiency or insufficiency worldwide between 2000 and 2014, the prevalence of folate deficiency was 0–11 per cent in high-income countries, and 18–79 per cent in low-income countries (Martinez *et al*., 2023; Rogers *et al*., 2018). This can be partly associated with low FA supplementation among women. In many studies conducted across different countries, including Japan, Pakistan, Poland, Korea and Nigeria, a very low proportion of childbearing-age women (9–38 per cent) were found to take FA supplements during their periconceptional period (i.e. both prior to pregnancy and after conception), or before pregnancy (Chaudhri *et al*., 2019; Kim *et al*., 2018; Okon *et al*., 2020; Yamamoto and Wada, 2018; Zadarko-Domaradzka *et al*., 2021). FA supplement intake or supplementation refers to taking a FA supplement or a multivitamin containing FA regularly at the given time. Factors correlated with better FA supplementation include knowing FA's benefit (Yamamoto and Wada, 2018) and its role in NTD prevention (Zadarko-Domaradzka *et al*., 2021), marriage and having pregnancy experience (Al-Mohaithef *et al.,* 2021; Kim *et al*., 2018), older age (35 years old or more) (Yamamoto and Wada, 2018) and health science specialisation (Al-Mohaithef *et al*., 2021). However, the knowledge level of this population group regarding FA or folate was also reported as low, with only 8–43 per cent of women being identified as knowledgeable in many studies (Abdulrazzaq *et al*., 2003; Al-Mohaithef *et al*., 2021; Hisam *et al.* 2014; Kim *et al*., 2018; Zadarko-Domaradzka *et al*., 2021). Knowledge of FA and folate refers to knowing the benefits of FA during pregnancy, the recommended dose to take as a supplement, when the FA supplement should be taken in relation to the pregnancy period, and other related concepts. The low knowledge level and the insufficient FA supplement intake reported across the aforementioned studies underscore the necessity of giving priority to the issue and the need for

further investigation of the topic to support effective health interventions.

Regarding the UAE, a recent finding from the United Arab Emirates Birth Cohort Study (UAEBCS) showed that folate intake of all first-trimester pregnant women of UAE nationals (100 per cent) was below the recommended dietary allowance (RDA) or adequate intake. Studies show an average intake of 112.9µg/day folate compared to the recommended amount of 600µg/day (Mutare *et al.*, 2025), which indicates the importance of taking FA supplements to meet the need. However, up-to-date scientific literature on the FA supplementation of all childbearing-age women by including non-pregnant women and different nationalities is missing. Additionally, although **awareness and knowledge of folic acid or folate** have been significantly associated with an uptake in FA supplementation in women (Medawar *et al.*, 2019; Sabi *et al.*,2022), evidence regarding the current awareness and knowledge level of childbearing-age women in the country – especially among those who have never had a pregnancy experience – is lacking. Awareness of FA or folate refers to having heard about FA or folate. To the best of the authors' knowledge, only two studies (conducted in 2003 and 2010) of pregnant or postpartum women at healthcare centres are available, both reporting conflicting findings regarding prevalent awareness and knowledge level of FA (Abdulrazzaq *et al.*, 2003; Al-Hossani *et al.*, 2010). In the 2003 study, only 8.7 per cent of participants (i.e. postpartum women) knew about FA, particularly about its role, and only 46.4 per cent had heard about FA besides having insufficient FA supplementation (45.5 per cent) during their periconceptional period (preconception and in the first trimester) (Abdulrazzaq *et al.*, 2003). A better result was reported later in the 2010 study, in which 66.7 per cent of pregnant women knew the importance of FA in pregnancy and 79.1 per cent had awareness of the nutrient, but only 7.8 per cent took FA supplement before their pregnancy (Al-Hossani *et al.*, 2010). Regardless of these findings, the latest studies are missing in understanding the current awareness and knowledge of FA or folate, and the FA supplementation status of women in the country.

Additionally, the previous studies were conducted only at healthcare

centres predominantly targeting pregnant or postpartum women, and did not consider the involvement of those who never had a pregnancy experience or have never married, which limits the generalisability of their findings to the general population of childbearing-age women.

As a result, this study aimed to fill existing evidence gaps by including childbearing-age women with diverse demographic characteristics, such as those who had never been pregnant or married, and by conducting the research in a university setting rather than a healthcare environment, thereby broadening the scope beyond previous studies that focused solely on pregnant or postpartum women. The study particularly focused on the childbearing-age university female students because of a high potential for early interventions, especially to reduce the risk of NTDs, in this population group.

Aim and objectives of the study

The aim of the study was to evaluate the awareness and knowledge of dietary folate and FA, as well as the intake of FA supplements among female Zayed University students.

The objectives of the study were to:

1. evaluate the level of awareness and knowledge of dietary folate and folic acid
2. assess folic acid supplement use
3. analyse major demographic factors associated with knowledge of folate (i.e. dietary folate and folic acid) and folic acid supplementation
4. assess the risk of inadequate dietary folate intake among female students.

Methodology

Study design and participants

This study was descriptive and correlational research conducted on 239 eligible Zayed University female students of both Abu Dhabi and Dubai campuses who were 16–40 years old. The data was collected online using Google Forms between 10 October and 2 November 2023. The required sample size was estimated as 359 using an online sample calculator tool,

calculator.net, taking the population (all active childbearing-age women in both Zayed University campuses) size as 5264, confidence level as 95 per cent, margin of error as 5 per cent and population proportion as 50 per cent. The sample size calculator tool was used to ensure the study is fully powered by recruiting a sufficient number of participants to produce the true outcome and to ensure reproducibility of the outcomes (Althubaiti, 2022). To recruit the target participants, a list of 5264 actively enrolled female students on both campuses was obtained from the university's registration office, and they were contacted through the institutional email system, inviting them to voluntarily participate in the study by completing the survey. The survey was administered online using Google Forms and designed to be self-administered. Volunteer participants were invited to complete the questionnaire anonymously and at their own convenience within the designated data-collection period. An invitation email, distributed through the university's institutional email system, contained the survey link and detailed instructions for completion. An electronic participant information sheet was embedded within the survey, and informed consent was obtained electronically before participants were granted access to the questionnaire. This study was approved by the Research Ethics Committee at Zayed University, UAE (ZU23_062_S).

Study instrument

The survey consisted of a closed-ended multiple choice questionnaire adapted from previous successful studies (Alblowi and Alomayri, 2018; Kim *et al*., 2018), which had a similar aim and objectives as well as population characteristics as the current study, was used to collect data on awareness and knowledge of folate or FA, and FA supplement use, as well as related to the eating habits of the participants in addition to demographic characteristics.

The first part of the questionnaire included demographic characteristics (nationality, age, specialisation, income, marital status, pregnancy experience), personal history of folate or anaemia deficiency, and family history of congenital disorders. The second part assessed awareness and

knowledge of folate and FA, the third part evaluated FA supplement use, while the fourth part examined the eating habits of the participants to determine their risk level of not taking adequate folate from food. The awareness domain question was 'Have you heard about folic acid or folate?', with yes/no options to choose from which were then assigned 0 and 1 values for analysis purpose (1 = yes, 0 = no); questions used to assess knowledge were, for example, 'What is folic acid?', with one correct and more incorrect options to choose from, which were then assigned 0 and 1 values for analysis (0 = for all incorrect options, 1 = correct option); the question used to evaluate FA supplement intake was 'Do you take folic acid supplements or a vitamin containing folic acid regularly?' and the options were yes/no which were then assigned 1 and 0 values (1 = yes, 0 = no) for analysis purpose. Additionally, the questions utilised to examine the risk level of inadequate folate intake were, for example, 'In the past month, how often did you eat beans?', along with five options (less than 3 times/month, 1–2 times/week, 3–4 times/week, 5–6 times/week, 1–2 times/day and 3 or more times/day), which were assigned a value 0 to 5 (0 = least frequent, 5 = most frequent). All these and the remaining utilised questions are included in the Appendix (at the end of this article).

Definition of awareness, knowledge, folic acid supplementation and inadequate folate intake

FA or folate awareness was defined as having heard of FA or folate. Knowledge of FA and folate was defined as knowing that FA/folate prevents birth defects and that FA should be taken before pregnancy for the prevention of birth defects, that folate/FA is vitamin B, and other similar concepts. 'Good knowledge' was defined as answering half or more than half of the knowledge questions correctly, while 'Poor knowledge' was defined as answering less than half of the questions correctly. FA supplement intake (use) was defined as taking FA supplements or multivitamins containing FA regularly at the time of the study. Adequate folate intake (i.e. adequate dietary folate intake) was defined as reporting more frequent consumption of folate-rich foods; therefore, inadequate folate intake was defined as reporting lower-consumption frequencies on

the eating habit checklist.

Statistical analysis

The data was analysed using SPSS version 29.0, and frequencies and percentages were calculated for categorical variables while percentiles were computed for numerical variables. Individuals who previously heard about folate or FA were considered to have awareness, and those who regularly took FA supplements or vitamins containing FA were assumed to have taken FA supplements (or have positive FA supplement usage or intake).

Knowledge was assessed by counting the total number of questions individuals answered correctly, and then by comparing everyone's total number of questions answered correctly against half (50 per cent) of the knowledge questions. The total number of knowledge questions was six, so 50 per cent of the questions were three. Knowledge level was categorised into two: individual total counts of correctly answered questions equal to or more than 50 per cent of the knowledge questions (i.e. three) were grouped as 'Good knowledge', and those less than 50 per cent were classified as 'Poor knowledge'.

While analysing the risk level of inadequate folate intake, scores were calculated at the individual level by adding up the values of selected options for all questions for each participant, and the obtained score was compared against the percentile scores of the sample population. The risk level was classified into three using the 33rd and 67th percentiles as cut-offs for the classification. Thus, individuals who scored less than or equal to 12 (i.e. 33rd percentile) were considered a high-risk group, those who scored from 13 to 16 (i.e., above the 33^{rd} percentile up to the 67th percentile) by including both 13 and 16 considered as moderate risk, and those who scored greater than 16 were considered as a low-risk group. The significance of associations of demographic factors with awareness, knowledge, FA supplement intake and risk level of inadequate dietary folate intake was determined using chi-square test. However, where the assumption of the chi-square test was broken, fisher's exact test (2-sided)

and likelihood ratio were applied.

Results

Out of the 5264 participants invited to participate, 239 participated in this study, matching a 67 per cent response rate. Demographic profiles of the participants (n = 239) were analysed and summarised with frequency and percentage as shown in Table 1. Most of them (97.1 per cent) were UAE nationals or Emiratis, 16–24 years old (95.8 per cent), and were studying fields outside of health science (63.6 per cent). Also, 93.3 per cent of the participants were single or never married. Most did not have a history of folate deficiency or anaemia (n = 149, 62.3 per cent), and only a few reported having a family member with a congenital disorder (13.4 per cent).

		Count	Column N %
Nationality	**Non-Emirati**	**7**	**2.9%**
	Emirati	**232**	**97.1%**
Age(years)	**16-24**	**229**	**95.8%**
	25-40	**10**	**4.2%**
Field of study	**Outside of health fields**	**152**	**63.6%**
	Health Science	**87**	**36.4%**
Marital status	**Single (Never married)**	**223**	**93.3%**
	Married or divorced	**16**	**6.7%**
Pregnancy experience (was prevalent only among married or divorced)	**No**	**8**	**50.0%**
	Yes	**8**	**50.0%**
If ever had a child with congenital anomalies (only among those had pregnancy experience)	**No**	**8**	**100.0%**
	Yes	**0**	**0.0%**
Having family member who has congenital anomalies	**No**	**207**	**86.6%**
	Yes	**32**	**13.4%**
History of folate deficiency or anemia	**No**	**149**	**62.3%**
	Yes	**90**	**37.7%**
Average monthly income of the household	**Don't know or prefer not to tell**	**124**	**51.9%**
	Less than 5000AED	**13**	**5.4%**
	5000 to 20,000 AED	**24**	**10.0%**
	More than 20,000 AED	**78**	**32.6%**

Table 1. Demographic characteristics of the participants (Authors' collection)

Awareness and knowledge level of participants regarding folate and folic acid

Overall, 63.2 per cent of participants involved in this study were aware of folate or FA. However, the majority had poor knowledge (n = 132, 55.2 per cent), and those who had good knowledge about folate or FA were only 44.8 per cent, as shown in Figure 1. Among all of the participants, more than a third (41 per cent) knew that folate is a type of vitamin B, and 53.6 per cent knew that it helps with red blood production, neural tube formation, brain and spinal cord growth, and decreases miscarriage and preterm labour. Also, 52.3 per cent correctly identified the foods that are rich in folate. However, a higher proportion of the participants did not know the major health problems caused by FA deficiency during pregnancy (46.4 per cent), the appropriate period of taking FA for effective prevention of foetal malformations (53.6 per cent) and the daily recommended dose of FA for childbearing-age women (66.9 per cent).

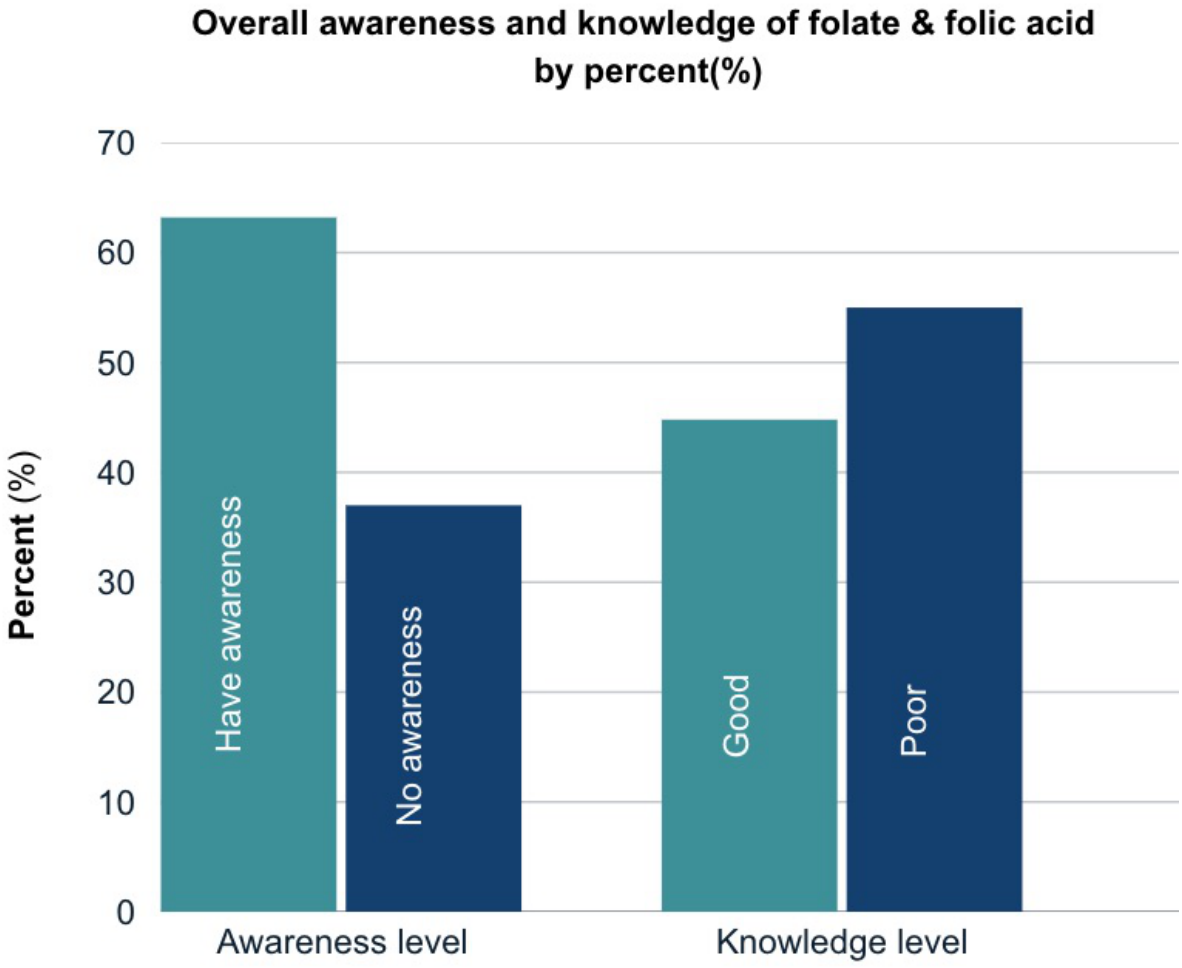

Figure 1. Overall awareness and knowledge level of folate and folic acid by per cent (%) (Authors' collection)

As shown in Figure 2, common sources of information on folate and FA for participants were health professionals (38.9 per cent), family (31.4 per cent) and social media (22.2 per cent).

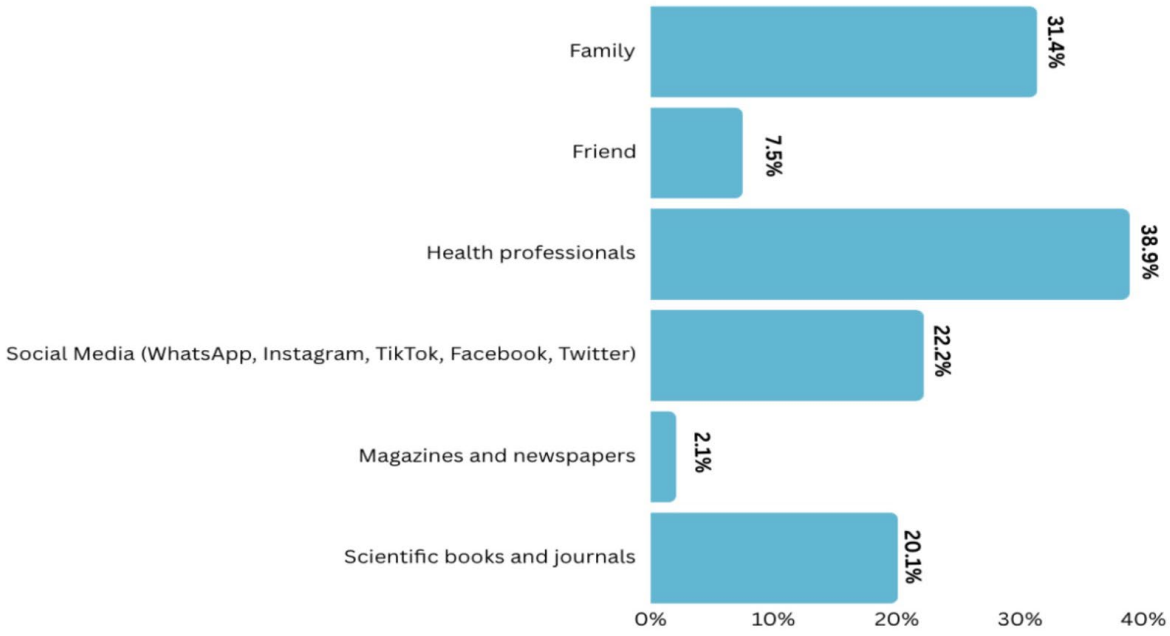

Figure 2. Common information sources of folate/FA (Authors' collection)

Intake of folic acid supplements and risk level of inadequate folate Intake

More than three-quarters (77.0 per cent) of participants never regularly took FA supplements or vitamins containing FA (i.e. they had negative FA intake), as shown in Figure 3. Also, based on analysis of the eating habit checklist, the majority were at higher risk of inadequate folate intake (38.5 per cent), and those at moderate and lower risk were 29.3 per cent and 32.3 per cent respectively.

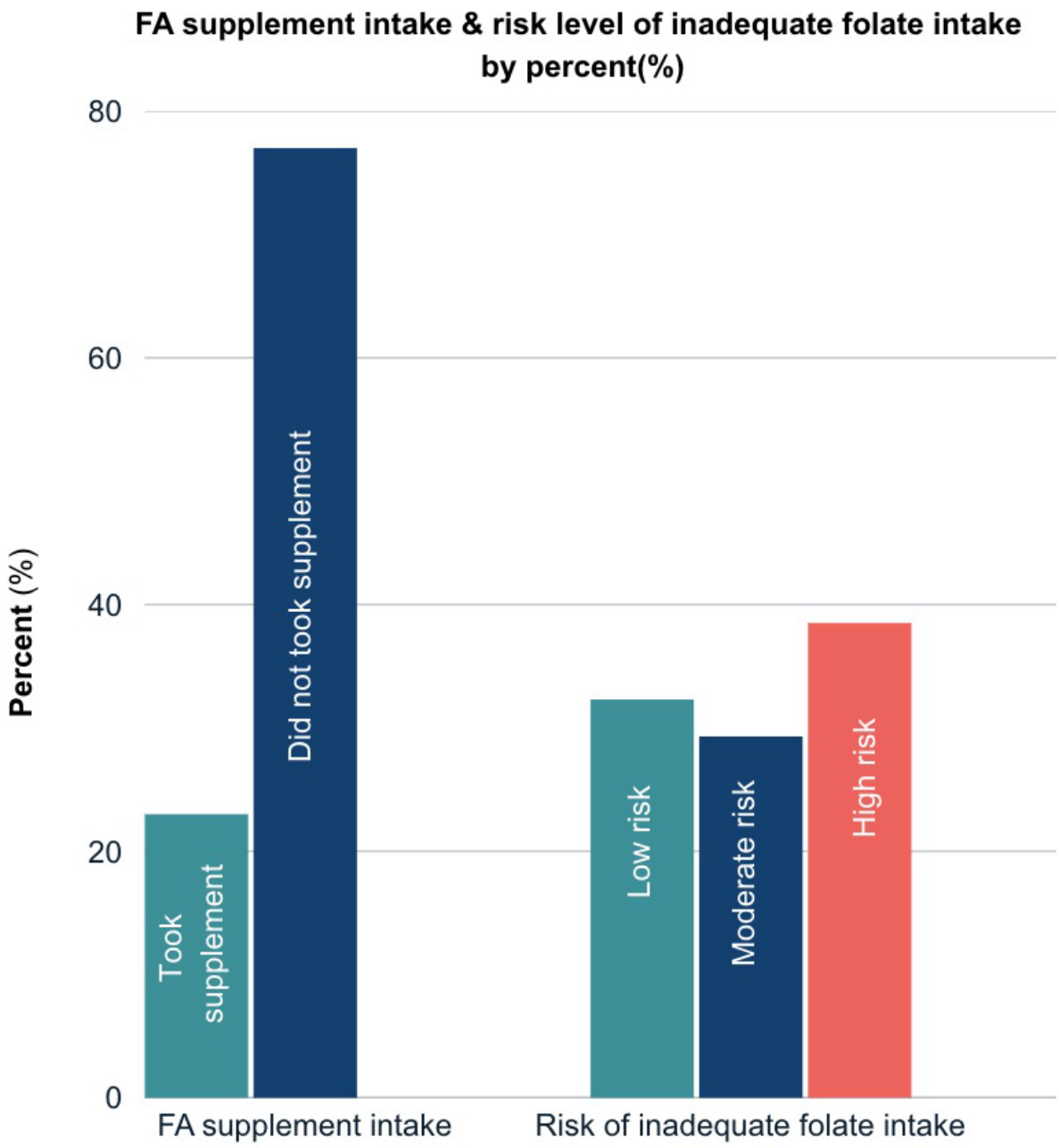

Figure 3. Level of folic acid (FA) supplementation and risk of inadequate folate intake among participants by per cent (%) (Authors' collection)

Association of demographic factors with awareness and knowledge of folate/FA

A significantly higher proportion of individuals enrolled in health science field, and those with a history of folate deficiency or anaemia, had heard about folate or FA (i.e. had awareness) compared to those enrolled in non-health-related fields and those with no history of folate deficiency or anaemia ($p < 0.001$ and $p = 0.048$, respectively) (see Table 2). Those

participants were also identified as being more knowledgeable ($p < 0.001$, and $p = 0.026$ respectively) along with married or divorced women ($p = 0.046$), as shown in Table 2. However, no significant difference in knowledge was observed in terms of nationality ($p = 1.000$), age ($p = 0.518$), pregnancy experience ($p = 0.282$) or having family members with congenital abnormalities or not ($p = 0.374$).

		If heard about folic acid or folate				Pvalue	Knowledge level				P-Value
		No		Yes			Poor Knowledge		Good Knowledge		
		Count	Row N %	Count	Row N %	Sig (Asymptomatic sig)	Count	Row N %	Count	Row N %	
Nationality	Non-Emirati	2	28.6%	5	71.4%	1.000Exact Sig.(2sided)	4	57.1%	3	42.9%	1.000-Exact Sig(2sided)
	Emirati	86	37.1%	146	62.9%		128	55.2%	104	44.8%	
Age(years)	16-24	87	38.0%	142	62.0%	.097-Exact sig.(2sided)	125	54.6%	104	45.4%	0.518-Exact Sig.(2sided)
	25-40	1	10.0%	9	90.0%		7	70.0%	3	30.0%	
Field of study	Other Fields of Study	70	46.1%	82	53.9%	**<.001***	102	67.1%	50	32.9%	**<.001***
	Health Science	18	20.7%	69	79.3%		30	34.5%	57	65.5%	
Marital status	Single (Never Married)	85	38.1%	138	61.9%	.121	127	57.0%	96	43.0%	**.046***
	Married or divorced	3	18.8%	13	81.3%		5	31.3%	11	68.8%	
Pregnancy experience	No	3	37.5%	5	62.5%	.200(Exact Sig.2sided)	4	50.0%	4	50.0%	.282 (exact sign(2side)
	Yes	0	0.0%	8	100.0%		1	12.5%	7	87.5%	
Having family member who has congenital anomalies	No	77	37.2%	130	62.8%	.758	112	54.1%	95	45.9%	.374
	Yes	11	34.4%	21	65.6%		20	62.5%	12	37.5%	
History of Folate Deficiency or Anemia	No	62	41.6%	87	58.4%	**.048***	74	49.7%	75	50.3%	**.026***
	Yes	26	28.9%	64	71.1%		58	64.4%	32	35.6%	

Table 2.The association of demographic factors with awareness and knowledge of folate or folic acid (Authors' collection)

Note: Star (*) shows the p-value is ⩽ 0.05 and it is statistically significant.

Association of demographic factors with folic acid supplementation and risk of inadequate folate intake

Taking FA supplements or vitamins containing FA was statistically highly associated with being married or divorced ($p < 0.001$) and having a history of folate deficiency or anaemia ($p = 0.003$), as shown in Table 3. In contrast, no significant difference in terms of FA supplementation was observed among individuals with different nationalities ($p = 0.729$), age groups ($p = 0.244$), fields of study ($p = 0.335$), pregnancy experiences ($p = 0.119$), and having a family member with a congenital disorder or not ($p = 0.460$). Similarly, none of the factors, except having pregnancy experience ($p = 0.010$), were significantly associated with the risk level of inadequate folate intake.

		Intake of folic acid supplements or a vitamin containing folic acid regularly (at least once a week)					Risk level of inadequate folate intake					
		No		Yes			High risk		Moderate risk		Low risk	
		Count	Row N %	Count	Row N %	P=value	Count	Row N %	Count	Row N %	Count	Row N %	P=Value
Nationality	Non-Emirati	6	85.7%	1	14.3%	1.000 - Exact Sig(2sided)	2	28.6%	3	42.9%	2	28.6%	.729- Likelihood Ratio
	Emirati	178	76.7%	54	23.3%		90	38.8%	67	28.9%	75	32.3%	
Age(years)	16-24	178	77.7%	51	22.3%	0.244 - Exact Sig(2sided)	88	38.4%	67	29.3%	74	32.3%	.988- Likelihood Ratio
	25-40	6	60.0%	4	40.0%		4	40.0%	3	30.0%	3	30.0%	
Field of study	Other Fields of Study	114	75.0%	38	25.0%	.335	59	38.8%	47	30.9%	46	30.3%	.642
	Health Science	70	80.5%	17	19.5%		33	37.9%	23	26.4%	31	35.6%	
Marital status	Single (Never Married)	178	79.8%	45	20.2%	**<.001*** Exact sig (2-sided)	85	38.1%	65	29.1%	73	32.7%	.809
	Married or divorced	6	37.5%	10	62.5%		7	43.8%	5	31.3%	4	25.0%	
Pregnancy experience	No	5	62.5%	3	37.5%	.119 Exact sig(2-sided)	2	25.0%	5	62.5%	1	12.5%	0.010- Likelihood Ratio, *
	Yes	1	12.5%	7	87.5%		5	62.5%	0	0.0%	3	37.5%	
Having family member who has congenital anomalies	No	161	77.8%	46	22.2%	.460	80	38.6%	63	30.4%	64	30.9%	.469
	Yes	23	71.9%	9	28.1%		12	37.5%	7	21.9%	13	40.6%	
History of Folate Deficiency or Anemia	No	124	83.2%	25	16.8%	**.003***	56	37.6%	41	27.5%	52	34.9%	.498
	Yes	60	66.7%	30	33.3%		36	40.0%	29	32.2%	25	27.8%	

Table 3. Association of demographic factors with folic acid intake level and risk level of inadequate folate intake (Authors' collection)

Note: Star (*) shows the p-value is ⩽ 0.05 and it is statistically significant.

Discussion

This study found a good awareness level of folate/FA (63.2 per cent) among participants. However, this result was lower than the finding of a previous study conducted in the UAE in 2010 where 79 per cent of participants had heard about FA (Al-Hossani *et al*., 2010). This difference may be attributed to the population of the study. The previous study was conducted among pregnant or married women (Al-Hossani *et al*., 2010), groups who are more likely to receive formal information from healthcare providers during clinic visits. In contrast, the current study primarily involved single or never-married university students who have fewer opportunities to access such information through healthcare settings.

In the current study, less than half (44.8 per cent) of the participants had good knowledge of folate and FA regardless of their higher education level, which is approximately comparable to the 38.3 per cent knowledge level reported by Al-Mohaithef *et al.* (2021) from the Saudi Electronic University in Saudi Arabia. Regarding knowledge of specific aspects of folate and FA, 41 per cent of the current study's participants knew that folate is vitamin B, 53.6 per cent of them correctly identified the benefits of FA, and more than half (52.3 per cent) could distinguish foods rich in folate. This agrees with previous study findings of Alblowi and Alomayri (2018) where 31.7 per cent of participants knew the food group of folate, and 54.5 per cent could state that vitamin B helps with neural tube formation and brain and spinal cord growth. However, in the current study, the majority of the participants did not know the recommended dose of FA from the supplement (66.9 per cent), when FA supplement should be taken for effective prevention of malformations during pregnancy (53.6 per cent), and the major health problems FA deficiency can cause in a foetus (46.4 per cent). This finding is supported by evidence from a 2013 study conducted in the UAE, which reported that only 42 per cent of Emirati women were aware of the importance and benefits of FA intake prior to conception, and 51 per cent were unaware of the appropriate timing for supplementation (Alkaabi *et al.,* 2013; Mutare *et al.,* 2025). This underscores the necessity of education and awareness programmes to increase awareness and knowledge of folate or FA among young adult women across the UAE.

The current study found that only 23 per cent of the participants took FA supplements. This is slightly higher than the previous finding reported in 2010 within the UAE, where only 7.8 per cent of participants reported taking FA supplements prior to pregnancy (Al-Hossani *et al*., 2010). However, the current finding is lower by more than half compared to a recent finding in the region among university students (47.1 per cent), particularly at Saudi Electronic University in Saudi Arabia (Al-Mohaithef *et al.,* 2021). This observed difference could be due to differences in demographic profiles of the study population between the two studies, besides differences in the study setting. In Al-Mohaithef *et al.*'s study, the majority of the participants were married (53.8 per cent), and many of them were pregnant or had a history of pregnancy (49 per cent), unlike in the current study in which most were single or never married (93.3 per cent), and only 3.35 per cent had a history of pregnancy.

Studies have shown that awareness or knowledge of FA is significantly associated with women's FA supplement intake (Chaudhri *et al*., 2019; Hisam *et al.,* 2014; Kim *et al.,* 2018; Sabi *et al*., 2022). Therefore, to promote adequate FA supplement uptake in the UAE, effective education campaigns on the benefits of FA by targeting all childbearing-age women – especially those who are unmarried and therefore less likely to receive information during clinical visits – are needed.

The current study also found that a higher percentage of the participants (38.5 per cent) were at higher risk of inadequate folate intake, with those at moderate risk being 29.3 per cent while those at low risk were only 32.3 per cent. This was opposite to the findings of Kim *et al.* (2018), where the majority of the participants (37.4 per cent) were at low risk of inadequate folate intake from food, and those at higher risk were 31.8 per cent. The heightened risk of inadequate folate intake observed in the current study may be partly linked to the widespread adoption of Western dietary patterns, consisting of fast foods and sweets with low folate content, in the UAE. The country has undergone a rapid shift from traditional food habits and active lifestyles to Westernised diets and more sedentary behaviours (Mutare *et al.,* 2025). A recent study among first-trimester

pregnant Emirati women highlighted these changes, reporting that over half (56 per cent) exceeded the acceptable macronutrient distribution range (AMDR) for saturated fat, while the vast majority (94 per cent) consumed only about 10g of dietary fibre per day – far below the recommended 28g/day (Mutare *et al.,* 2025). Therefore, given the poor knowledge level found in the current study that might have contributed to the higher risk level, health professionals, who were identified as a major source of information (38.9 per cent), should strive to deliver accurate and in-depth information regarding folate and FA to the young adult women and their families. Also, families, as the second most common source of information reported in this survey (31.4 per cent), should be willing to learn about FA and folate as well as health in general, and share the information with their children responsibly.

Factors associated with knowledge of folate/FA and use of FA supplement

Based on the chi-square test, this study found that health science students and individuals who have a history of folate deficiency or anaemia were significantly more aware and knowledgeable of folate or FA than those whose field of study was different from health science and those who did not have a history of folate deficiency or anaemia. Similarly, married or divorced women had higher knowledge levels compared to those who never married. However, age, nationality and pregnancy experiences were not associated with both knowledge and awareness of folate or FA, although some previous studies reported the presence of an association; for instance, Abdulrazzaq *et al.* (2003) reported greater knowledge among non-UAE nationals compared to other nationalities. However, this disagreement could be due to a small proportion of different nationalities represented in the current study.

Regarding factors associated with FA supplement usage, Fisher's exact test indicated that married or divorced individuals were significant FA supplement users, while the chi-square test showed that those with a history of folate deficiency or anaemia also had positive FA supplement intake. However, the current study did not find a significant association

between FA supplementation and older age, health science specialisation, as well as pregnancy experience, although previous studies reported them to be associated with greater FA supplement usage (Al-Mohaithef *et al*., 2021; Kim *et al*.,2018; Yamamoto and Wada, 2018). This observed difference might be due to the small representation of individuals with older age and pregnancy experience in this study, so further studies with better representation are required. This research also found that individuals who had pregnancy experience were at higher risk of inadequate folate intake, which highlights the need for targeted education to enhance their knowledge level and, in turn, their FA intake before their next pregnancy.

The average monthly income of the household and having a child with congenital anomalies were not tested for association with awareness, knowledge and use of FA supplements or folate intake from food. The reason is that most of the participants responded that they do not know or prefer not to tell the average monthly income, and none of them has ever had a child with a congenital disorder.

In general, this study has effectively answered the main research question by identifying the level of awareness and knowledge of folate/FA and FA supplement usage among female Zayed University students. It also successfully evaluated the risk level of inadequate folate intake and distinguished the major demographic factors associated with knowledge level and FA supplementation among participants. To the best of the authors' knowledge, this is the first study investigating awareness, knowledge of folate/FA, and FA supplements among female university students in the UAE.

The limitation of this study is that the number of married or divorced women, those who had experience of pregnancy, and non-UAE nationals was small or underrepresented; thus, interpretation of the conclusions regarding the association of these factors with knowledge of FA/folate and intake of FA supplements requires caution. Also, students were not asked in which year of their academic programme they were, which might have an impact on the generalisability of the result to the target population.

Finally, a pilot study was not carried out in this study to test the validity of the questionnaire, especially for the questions used to assess the risk level of inadequate folate intake. Also, to assess the knowledge, one item asked 'Which health problem can mainly occur due to FA deficiency during pregnancy?' with options including **neural tube** defects/spinal cord defects, anaemia and low birth weight. However, because more than one option is defensible, the wording ('mainly') and single-best-answer format might have introduced **content ambiguity** and **misclassification** of individuals who chose a scientifically defensible, but non-expected, response. As a result, participants who selected a valid but non-expected answer could have received a lower score on this item, and in turn overall knowledge score below the cut-off. Consequently, these individuals may have been **incorrectly classified as having 'poor knowledge'** although their responses reflected a reasonable understanding of folic acid deficiency. This may have attenuated observed associations between knowledge and covariates. To evaluate its impact, the authors reclassified knowledge **after excluding this item** while retaining the cut-off (a priori rule of) **⩾50** per cent **considered as 'Good knowledge' level**. The numerical cut-off shifted from **3/6** to **2.5/5**; however, because individual scores are integers, the **operational threshold remained ⩾3** correct. Consequently, the **proportions categorised as good vs poor knowledge were unchanged; thus, the knowledge outcomes without excluding the item were kept**. However, the authors acknowledge this measurement limitation and the need for caution when interpreting the knowledge result. Additionally, the use of tertiles (i.e. 33rd and 67th percentiles) as cut-off to classify the risk level of inadequate dietary folate intake in this study, mainly yields **relative, sample-dependent ranking** rather than an absolute indicator of inadequacy. Therefore, the obtained estimates may be **less comparable across studies** and may **misclassify** individuals near clinically meaningful thresholds.

Recommendation

Future studies

- To investigate awareness and knowledge of folate and FA supplementation among female University students in the United Arab Emirates by considering a larger sample size with adequate representation of non-UAE nationals and those who have married or divorced marital status, as well as those who have experienced pregnancy.

Public health practice

- To have awareness education programmes and campaigns across the university campuses to raise the knowledge of female students about the necessity of folate and FA and the health problems associated with its deficiency, and to promote the consumption of foods rich in folate and FA supplementation.
- Health professionals need to communicate adequate information about folate using different media and programmes, as they have been identified as the major information sources for this population group. Also, community campaigns should target parents since parents are major information sources for their children.
- The government should consider other alternative options, such as mandatory fortification of staple foods to ensure adequate folate intake among all community members (Berry *et al*., 2010). Mandatory FA fortification has been shown to prevent NTDs: in 2020, 61,680 FA preventable spina bifida and anencephaly cases were prevented through mandatory FA fortification of cereal grains in 58 countries (Kancherla *et al*., 2022). Thus, adapting the mandatory fortification policy can have a significant impact on reducing NTDs in the UAE.

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Figure 1. Overall awareness and knowledge level of folate and folic acid by per cent (%)

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(All figures are produced by the authors)

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Appendix

Questions used to assess awareness, knowledge, folic acid intake and risk level of inadequate folate intake

Awareness and knowledge about folic acid

1. Have you heard about folic acid or folate? (Awareness)

- Yes
- No

2. What is folic acid? – Knowledge (K)

- Mineral
- **Vitamin B –** correct answer
- Vitamin C
- Vitamin D
- I don't know

3. What is the benefit of folic acid? – K

- **Red blood production, Neural tube formation and brain and spinal cord growth, decreased miscarriage and preterm labor**
- Increase bone strength
- Protection from cancer, coronary disease
- I don't know

4. Which health problem can mainly occur by folic acid deficiency during pregnancy? – K

- **Neural tube defect/spinal cord defects**
- Anaemia
- Birth of low-weight child

- I don’t know

5. When should folic acid be taken for effective prevention of foetus malformations? – K

- In the first trimester
- **3 months before pregnancy and the first trimester**
- Mid-pregnancy
- Not necessary
- I don’t know

6. Which of the following foods is (are) a rich source of folate – K

- **Leafy vegetables like spinach, legumes like beans, whole grains, fruits**
- Chicken, beef sticks, fish, puddings
- Cream, candies, ham
- Mushroom, spices, salad dressing
- I don’t know

7. What is the dose of folic acid required daily for a woman planning to conceive or for a pregnant woman? – K

- 4mg
- **400 micrograms**
- I don’t know

8. From whom did you hear about the importance of folic acid? (Please tick all that apply)

- Family members
- Friend
- Health professional (i.e. Doctor, Obstetrics & Gynaecology, etc.)
- Social Media (WhatsApp, Instagram, TikTok, Facebook, Twitter)
- Magazines and newspapers
- Scientific books and journals
- I don’t remember

Intake of Folic Acid supplements

1. Do you take folic acid supplements or a vitamin containing folic acid regularly (at least once a week)?

- Yes
- No

Risk level of inadequate folate intake

1. In the past month, how often did you eat 3 meals per day? (**Most frequent is desirable)**

- Never
- 1–3times/month
- 1–2times/week
- 3–4times/week
- 5–6times/week
- Everyday

2. In the past month, how often did you have enough time for breakfast?

- Never
- 1–3times/month
- 1–2times/week
- 3–4times/week
- 5–6times/week
- Everyday

3. In the past month, how often did you eat rice?

- Less than 3 times/month
- 1–2 times/week
- 3–4 times/week
- 5–6 times/week
- 1–2 times/day
- 3 or more times/day

4. In the past month, how often did you eat or drink oranges/orange juices?

- Less than 3 times/month
- 1–2 times/week
- 3–4 times/week
- 5–6 times/week
- 1–2 times/day
- 3 or more times/day

5. In the past month, how often did you drink milk?

- Less than 3 times/month
- 1–2 times/week
- 3–4 times/week
- 5–6 times/week
- 1–2 times/day
- 3 or more times/day

6. In the past month, how often did you eat meat (such as liver, chicken giblets, etc.)?

- Less than 3 times/month
- 1–2 times/week
- 3–4 times/week
- 5–6 times/week
- 1–2 times/day
- 3 or more times/day

7. In the past month, how often did you eat beans?

- Less than 3 times/month
- 1–2 times/week
- 3–4 times/week
- 5–6 times/week
- 1–2 times/day
- 3 or more times/day

8. In the past month, how often did you eat green vegetables (e.g. spinach, broccoli, asparagus, cabbage, etc.)?

- Less than 3 times/month
- 1–2 times/week
- 3–4 times/week
- 5–6 times/week
- 1–2 times/day
- 3 or more times/day

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Glossary of terms

Awareness and knowledge of folic acid or folate: Having heard the term 'folate' or 'folic acid' (FA) at any time.

Congenital disorder: Defects or abnormalities in the baby's body that develop during pregnancy.

Content ambiguity: A situation in which a statement can be understood in more than one way and may therefore cause confusion.

Folate: Generic term for vitamin B9 that encompasses both natural (dietary) folates found in foods and the synthetic form, folic acid (FA), which is primarily used in food fortification and supplementation. Dietary folate is naturally found in foods such as green leafy vegetables, beans, liver and fresh fruits (MedlinePlus, 2023).

Folic acid: A synthetic form of folate usually taken as a supplement or by consuming fortified foods. Also known as FA.

Neural tube: A structure that is formed in the foetus during the early stage of pregnancy, usually before the 6^{th} week of conception, and later develops into the baby's spinal cord, spine, brain, and skull. At early stage of the pregnancy, normally, these tubes are closed, but failure of their closure causes a disability called neural tube defects.

Neural tube defects: Defects on the brain and spinal cord of a baby that develop due to improper closure of the neural tubes during the first month of pregnancy and the problem is mainly linked to folate deficiency in the

baby's mother. Also known as NTDs.

Misclassification: Refers to the incorrect categorization of individuals. In this study's context, it refers to assigning participants to the *'poor knowledge' of folate* category when, in the absence of questionnaire design limitations, they would more accurately have been classified as having *'good knowledge.'*

Monoglutamate: A Folate molecule containing only one glutamic acid residue in its structure (McNulty, 2024)

Polyglutamate: A folate molecule containing multiple glutamate residues or units in its structure (McNulty, 2024).

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A Machine Learning Approach to Augment Security in NFC-Based Access Control Systems

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Abstract

Near-field communication (NFC) is widely used in access control systems such as payment processing and regulating access to facilities. Due to its decentralised nature, NFC is constrained by resource limitations, making it vulnerable to exploits such as key cloning. This study investigated the effectiveness of machine-learning algorithms in visually distinguishing cards as an added security measure against unauthorised cloned cards.

The methodology includes collecting datasets, building classification models (CNN, KNN and SVM), performance evaluations and integration of the best-performing model into an NFC prototype, *Clone Guard*. Performance evaluations included accuracy, precision, F1-score and recall metrics. We found that CNN was the best-performing model, with a prediction accuracy of 96 per cent.

Experimental results showed that noisy datasets produced a more robust model than noiseless datasets. Heatmap visualisations indicate that distinct colours and bold text regions contributed significantly to the model's decision-making. Despite the high accuracy on test data, the prototype performed less accurately when classifying scanned cards.

The study provided a basic evaluation of classification algorithms, concluding that deep learning offered greater suitability. The implications of the prototype extended into the applied research domain, offering a configurable and deployable solution to improve the resilience of NFC-based access systems against unauthorised cloned cards.

Keywords: Near-field communication-based access systems, clone card detection, visual authentication using machine learning, deep learning (CNN) for NFC security, Image-based card verification.

Introduction

Near-Field Communication (NFC) is a wireless technology that facilitates communication between devices over short distances. NFC technology is widely ingrained in our day-to-day life primarily due to its ease of use, simplicity and various use cases such as in smart posters, e-payments and facility access control systems.

However, despite its versatile applications, NFC technology imposes various resource and storage constraints, leaving it susceptible to security exploits, including key cloning (Lee *et al.*, 2021; Singh *et al.*, 2018). Furthermore, the emergence of hacktivist devices like the Flipper Zero has simplified the card-cloning process, making it widely available to anyone regardless of technical skill set (Flipper Devices Inc., 2024). Considering the context of access control systems, cloning valid access cards is both a cyber and physical security concern as it provides unauthorised access to physical facilities, generally unbeknown to the victim or security personnel. For corporate businesses and other industries that rely on secure access control, unauthorised access to their physical assets presents a range of privacy and financial implications (Bernard, 2017).

Recognising this as a contemporary security challenge, this paper explores two key research

questions:

1. How effective are existing supervised machine-learning techniques in visually identifying access cards?
2. How feasible is the proposed solution for real-world implementation?

The remainder of this paper is organised as follows: in the Literature Review, we summarise related work to establish the academic context. The Methodology section outlines our approach, including the testbed setup and system design. We then present quantitative comparisons, supported by qualitative analysis of model and system performance in the Results section. Finally, we provide a summary of the paper's key contributions and conclude the paper by suggesting directions for future research in the Conclusion section.

Literature review

Despite the progression of technology, persistent NFC security vulnerabilities such as relay attacks, data corruption, eavesdropping, denial of service and cloning remain the focal point of contemporary research (Singh *et al.*, 2018). Countermeasures do exist and predominantly fall within two categories: protocol authentication, data analysis or both (Lee *et al.*, 2021; Yang *et al.*, 2023; Yang *et al.*, 2024). Authentication approaches dominate much of the current literature and are generally applied in the context of NFC-enabled smart devices. For instance, focusing on a university context, Bouazzouni *et al.* (2016) propose an access control architecture using Identity-Based Encryption and Trusted Execution Environments to verify the authenticity of both the user and the NFC reader. A similar implementation is explored by Ali Khan *et al.* (2020), where the authors propose a mobile application that requires users to verify a code sent via SMS after scanning an NFC tag before accessing a physical facility. By focusing on smart devices, these approaches circumvent the resource restrictions of traditional NFC systems, allowing for the application of stronger authentication and encryption techniques (Yang *et al.,* 2024).

Additionally, unique solutions consisting of both **machine learning** (ML) and protocol authentication were identified across various contemporary research (Bouazzouni *et al.*, 2016; Lee *et al.*, 2021; Yang *et al.,* 2024). Papers that applied ML typically leveraged classification techniques under supervised (Bouazzouni *et al.*, 2016; Gurulian *et al*., 2017; Lee *et al.*, 2021; Rengan, 2023) or semi-supervised models (Yang *et al.*, 2024). Lee *et al.* (2021) combined supervised deep-learning algorithms and radio frequency (RF) fingerprinting to determine NFC tag authenticity. The system achieved an identification accuracy of 96.16 per cent; however, concerns were raised about how different configurations could impact the ability of the system to interpret the signal characteristics. Inspired by this approach, Bouazzouni *et al.* (2016) focused on producing a less computationally expensive solution. The authors introduced an intrusion detection system where RF signal characteristics were compared by a **random forest algorithm**. Conversely, Yang *et al.* (2024) argue that the context of key-sharing supervised RF authentication is not well-suited given its extreme computational requirements and inability to accurately categorise malicious cards outside of the training dataset. To address this deficit, Yang *et al.* (2024) explored a semi-supervised model to train and calibrate the score of both legitimate and malicious RF signals and validated its performance in distinct applications.

While a variety of data analysis methods have been applied to enhance NFC security, the use of image-classification techniques to validate the physical features of NFC cards remains unexplored. Additionally, existing academic solutions often overlook usability and deployability. To address these gaps, this paper investigates the application of ML to enhance NFC security by introducing an **image-based classification approach** to detect cloned access

cards. Beyond theoretical analysis, it integrates a classification model into a functional NFC prototype in an experimental setting. The proposed solution prioritises practical usability, ensuring security personnel receive real-time notifications of cloned card usage. This approach strengthens NFC-based access control systems and provides a configurable and deployable system to mitigate unauthorised card use in real-world settings.

Methodology

We have chosen **design science research** as the methodological framework due to its structured approach to designing, prototyping and evaluating solutions in applied research (see Figure 1). Given the need for systematic NFC system integration and iterative refinement, this methodology provides a suitable structure for addressing the research objectives.

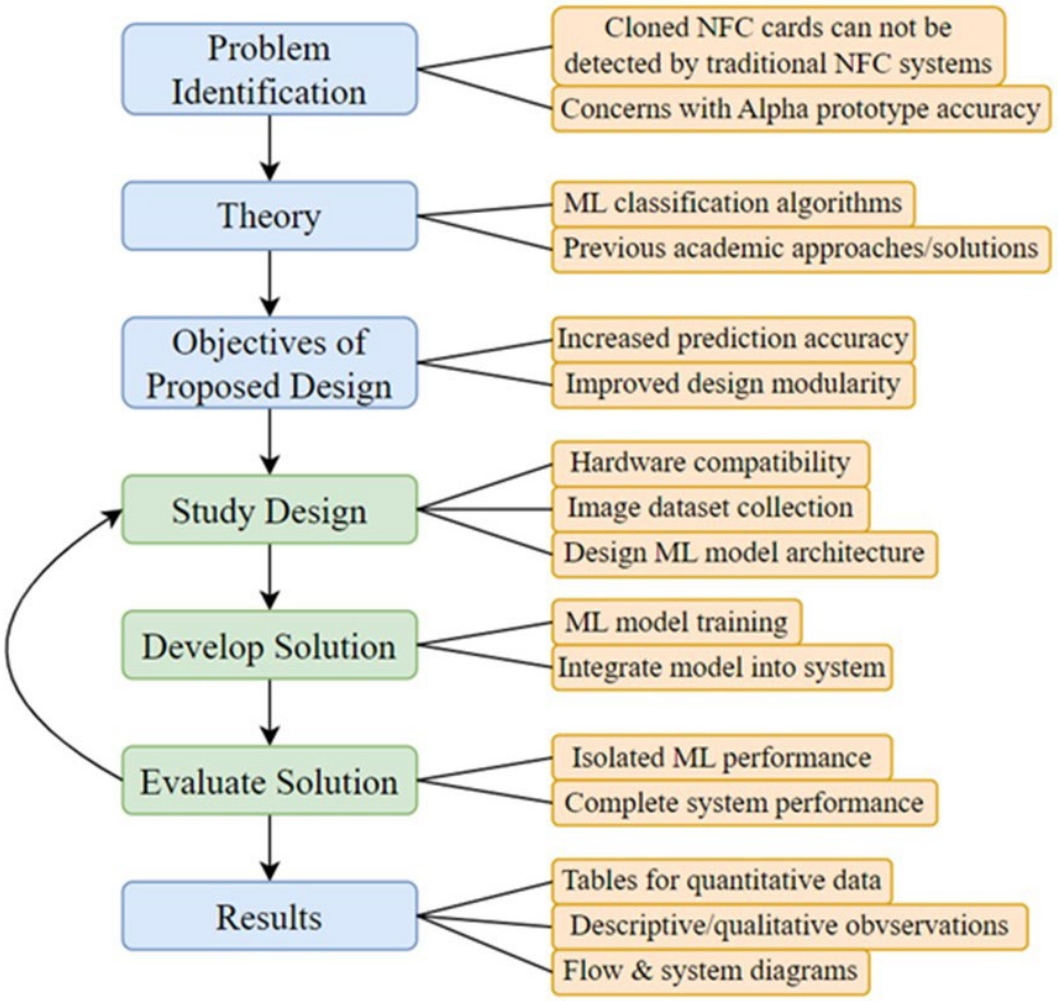

Figure 1. The phases of the research design methodology

Algorithm selection

The theory phase of design involved familiarisation with existing ML solutions applied not only to NFC security but to other image-classification applications. Three common algorithms – namely K-Nearest Neighbour (KNN), Support Vector Machine (SVM) and Convolutional Neural Network (CNN) – were noted due to their prevalence and suitability for similar image-classification use cases (Kanawade *et al.*, 2024). KNN was included due to its simplicity and effectiveness in low-dimensional feature spaces, making it suitable for rapid similarity-based classifications of distinctively different access cards. SVM was selected for its robustness with

smaller datasets with complex boundaries, making it suitable for identifying distinct features of keycards based on their visual data. Lastly, CNN was selected as the algorithm excels at learning complex features, enabling it to concentrate on prominent visual elements such as logos or text.

ML enhanced NFC prototype

The primary objective was to implement and evaluate a typical NFC access system enhanced with an integrated ML model capable of predicting the visual authenticity of the presented card (Figure 2). The system is subdivided into three subsystems: the NFC reader, the ML model and the alert mechanism. The NFC system mimics traditional access control behaviour using a MFRC522 NFC reader, which allows a user to scan their card and receive an LED indication of whether access is granted or denied. When a unique identifier (UID) is detected, the connected Raspberry Pi Camera Module 2l captures an image of the card. The image is then passed to a pre-trained classification model for analysis. If classified as valid with at least 75 per cent confidence, access is granted. If the features are inconsistent with expected characteristics, the attempt is flagged as fraudulent and access is denied. Failed attempts will also trigger email notifications to relevant security personnel. Source code for this prototype and the implemented algorithms is available on GitHub (Gullotta and Prego, 2025).

Hardware

Hardware selection for the initial prototype was largely influenced by simplicity, cost-effectiveness and ease of acquisition. The MFRC522 NFC reader, selected for its compatibility with Raspberry Pi microcontrollers, supports reading and writing for ISO/IEC 14443 A/MIFARE and NTAG cards at 13.56MHz (NPX, 2016). The typical signal distance for this module is within 50mm; however, in our instance the card was always scanned within 5mm of the reader. A 3D-printed casing was made for the reader and LED positioning. Testing confirmed that the casing did not affect NFC read accuracy or reliability.

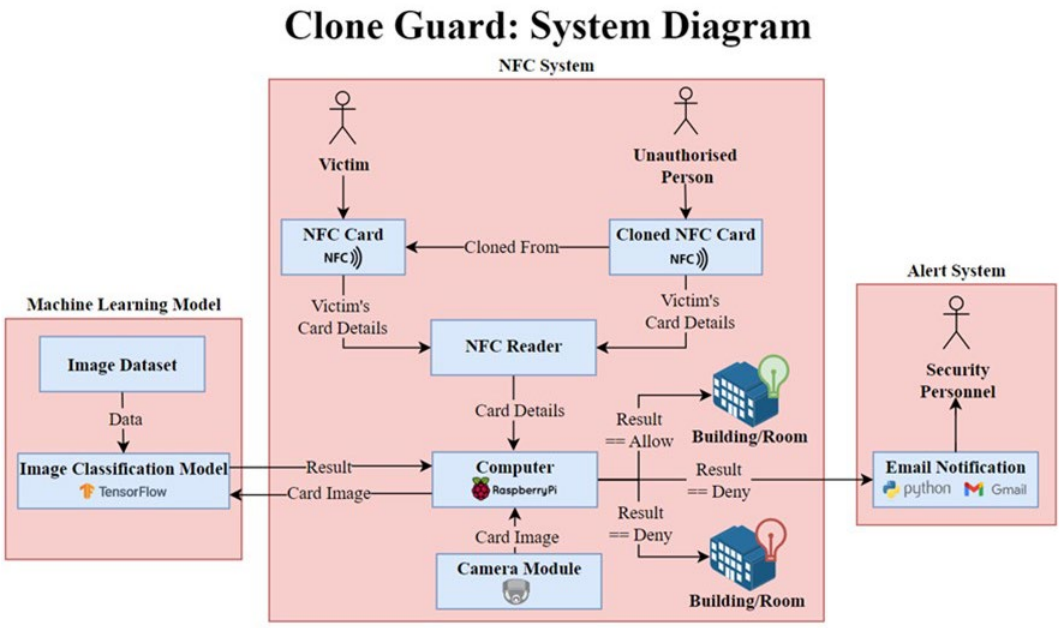

Figure 2: System model of the *Clone Guard* prototype

Dataset collection and preprocessing

Back and front images of 12 cards were collected using a Python script (Gullotta and Prego, 2025) to streamline the collection and categorisation of a sufficient volume and variety of data. The resulting dataset was organised into nine classes (Appendix A). A **multi-class approach** was chosen over a traditional binary classification to provide greater transparency in the model's decision-making process.

In total, 2700 images were collected with equal distribution across all classes. To introduce variety, images were captured at time intervals while cards were repositioned between shots. This produced natural differences such as glare, blur and partial framing.

The target class consisted of university student cards. To avoid **overfitting** to non-relevant details (e.g. a single student's photo), three different student cards were used. While this is acknowledged as a limitation, CNN **heatmap visualisations** suggested that the model primarily focused on broader card regions rather than individual faces or IDs. The other categories were selected to represent cards with physical similarities to the target (e.g. colour, layout or text placement), creating a realistic challenge for the classifier. Two datasets were constructed from this process: one with an optimistic noiseless white background and the other with a realistic, noisy background. As part of preprocessing, pixel normalisation was applied to scale values from [0, 255] to [0, 1], ensuring uniform feature contribution during training (Singh and Singh, 2020). No additional augmentation, cropping or custom feature extraction was performed, allowing the CNN to learn features directly from the raw image data.

CNN heatmaps revealed that distinctive background features (e.g. chairs) were influencing model predictions. To address this, two strategies were considered: (1) introducing greater variability in background conditions, and (2) applying preprocessing methods such as cropping or denoising. Given the exploratory nature of this prototype, we adopted the first approach and collected a third dataset of 1200 images with increased background variability. Class labels were also simplified into four categories (see Appendix B), aligning with the practical goal of distinguishing between valid and invalid cards.

Performance evaluation

The experimental testbed consisted of a CPU laptop with four cores, 16GB RAM and 3.30GHz frequency on which each algorithm was trained and evaluated in separate Jupyter notebooks. The image datasets were categorised in a folder structure, with folder names representing the corresponding class labels.

Python functions from the sci-kit-learn module were used to automate **classification reports** and **confusion matrices** for each model. This provided various quantitative values including **precision**, **recall**, **F1-score** and overall accuracy for each class. We also conducted a comparative analysis based on the mentioned metrics and recorded any qualitative observations. Once the most suitable model was identified, it was integrated into the simulated NFC system, and further end-to-end performance testing was conducted manually. The CNN model output was converted into a TensorFlow Lite format to optimise performance.

$$precision = \frac{True\ Postitives}{True\ Positives + False\ Positives} \quad (1)$$

$$recall = \frac{True\ Postitives}{True\ Positives + False\ Negatives} \quad (2)$$

$$f1\ score = \frac{precision \times recall}{precision + recall} \quad (3)$$

$$accuracy = \frac{True\ Postitives + True\ Negatives}{True\ Positives + False\ Positives + False\ Negatives + True\ Negatives} \quad (4)$$

Results

Experiment 1: Evaluation of machine-learning algorithms for card classification

The objective of the first experiment was to evaluate the suitability of SVM, KNN and CNN classification algorithms for accurately labelling various NFC card types. This experiment aimed to address the first research question by assessing the effectiveness of **deep learning** in image-classification tasks compared to traditional ML models.

For SVM and KNN, preprocessing involved resizing all images to 23 × 23 pixels, followed by dataset partitioning into training (80 per cent) and validation (20 per cent) sets and 36 testing images, with a **fixed random seed** of 123. Each partition was normalised by scaling pixel values from [0, 255] to [0, 1]. Prior to testing, **hyperparameter** optimisation was performed using Scikit-Learn's Grid Search to determine the best hyperparameter configurations for each model (see Table 1 as well as Appendix C for the CNN model architecture).

Algorithm	Seed	Image Dimensions	Hyperparameters
CNN	123	240 x 240	
SVM	123	23 x 23	{ n_neighbours = 1 }
KNN	123	23 x 23	{ kernel = 'rbf', gamma = 0.001, C=10 }

Table 1. Summary of configuration and parameter values used across the implemented algorithms. CNN model architecture can be found in Appendix C

The CNN model followed a slightly different preprocessing approach. Images were resized to 240 x 240 pixels using OpenCV and split into training (80 per cent) and testing (20 per cent) sets with a random seed of 123. The pixel values were normalised from [0, 255] to the [0, 1] range before being passed directly to the CNN model. The CNN model was implemented using TensorFlow (TensorFlow, 2025) and trained over 10 epochs.

To assess each model's performance, the trained classifiers were applied to the test dataset, and classification predictions were generated for all nine classes. A comprehensive description of each class is provided in Appendix A. Performance metrics – including precision, recall, F1-score and accuracy as defined in (1), (2), (3) and (4), respectively – were analysed using classification reports and confusion matrices.

SVM Classification Report				
	Precision	Recall	F1-Score	Support

BackColour	0.93	0.83	0.88	52
BackDL	0.92	0.82	0.87	55
BackOther	1.00	0.83	0.91	59
Blank	0.94	0.95	0.95	64
FrontColour	0.62	1.00	0.76	56
FrontDL	0.95	0.84	0.89	64
FrontOther	0.80	0.82	0.81	57
UCBack	0.93	0.96	0.94	70
UCFront	0.96	0.79	0.87	63
Accuracy			0.87	540
Macro Average	0.89	0.87	0.87	540
Weighted Average	0.9	0.87	0.88	540

Table 2: SVM classification results

Referring to Table 2, the SVM model exhibited moderate classification performance, achieving an overall accuracy of 0.87. However, performance varied considerably across classes. In particular, the model struggled with the 'FrontColour' class, yielding a relatively low F1 score of 0.76. Despite this, the macro-averaged and weighted F1 scores were 0.87 and 0.88, respectively, indicating that while some class-level imbalances exist, the model performs reasonably well overall.

KNN Classification Report				
	Precision	**Recall**	**F1-Score**	**Support**
BackColour	0.95	0.71	0.81	52
BackDL	0.93	0.76	0.84	55
BackOther	0.93	0.97	0.95	59
Blank	0.71	0.95	0.81	64
FrontColour	1.00	0.93	0.96	56
FrontDL	0.94	0.91	0.92	64
FrontOther	0.93	0.96	0.95	57
UCBack	0.79	0.89	0.84	70
UCFront	1.00	0.92	0.96	63
Accuracy			0.89	540

Macro Average	0.91	0.89	0.89	540
Weighted Average	0.91	0.89	0.89	540

Table 3: KNN classification results

The KNN model slightly outperformed the SVM, achieving an overall accuracy of 0.89 as shown in Table 3. It maintained high precision and recall across most classes, with F1-scores ranging from 0.81 to 0.96. Notably, the 'FrontColour' and 'UCFront' classes achieved the highest F1-scores (0.96), while 'Blank' and 'BackColour' were the lowest (0.81). The macro and weighted average F1-scores were both 0.89, indicating consistent performance across classes.

CNN Classification Report				
	Precision	**Recall**	**F1-Score**	**Support**
BackColour	0.95	0.94	0.94	62
BackDL	0.95	0.92	0.93	61
BackOther	0.92	0.93	0.93	61
Blank	0.96	0.98	0.98	52
FrontColour	0.98	0.99	0.99	62
FrontDL	1.00	0.98	0.98	65
FrontOther	0.95	0.96	0.96	56
UCBack	0.96	0.96	0.96	53
UCFront	0.99	1.00	0.96	58
Accuracy			0.96	540
Macro Average	0.96	0.96	0.96	540
Weighted Average	0.96	0.96	0.96	540

Table 4: CNN classification results

The CNN model outperformed both SVM and KNN, achieving the highest overall accuracy of 0.96, as shown in Table 4. Precision, recall and F1-scores exceeded 0.90 across all classes, reflecting strong and consistent classification performance. 'FrontColour' achieved the highest F1-score of 0.99, while the lowest-performing classes, 'BackDL' and 'BackOther', still attained F1-scores of 0.93. Both the macro and weighted average F1-scores were 0.96, underscoring the model's superior generalisation and accuracy compared to the other models.

The experimental results suggest that CNN offers the most consistent and reliable performance across all classes. The deep-learning model effectively captured feature patterns within the dataset, leading to improved generalisation on unseen test samples.

Despite efforts to maintain consistent dataset partitions, discrepancies arose due to differences

in dataset randomisation between Scikit-learn and TensorFlow implementations. This is reflected in variations in class support values across Tables 2, 3 and 4. However, the overall weighted averages provide a reliable basis for model comparison.

CNN exhibited the highest accuracy and consistency, making it the most suitable choice for further experimentation and implementation. This discovery demonstrates the potential of deep learning in NFC security applications, as it effectively distinguishes between visually similar keycards with minimal misclassification.

Experiment 2: Dataset optimisation for improved classification performance

Experiment 2 aimed to assess how the CNN model performed with different dataset conditions: optimistic (white background), realistic (noisy background), and combined datasets. The goal is to determine which dataset configuration would yield the best generalisation performance while minimising overfitting.

To facilitate this, 36 images (4 from each class) were manually separated from the realistic dataset for use as an independent testing partition. The CNN model from Experiment 1 was used across three training scenarios:

- Test 1: Model trained using optimistic dataset (white background).
- Test 2: Model trained using a realistic dataset (noisy background).
- Test 3: Model trained using a combination of both datasets.

Each model was evaluated using classification reports, confusion matrices and accuracy plots. The learning curves for each test were analysed to examine training and validation loss trends.

Training Dataset Experimentation									
	Optimistic Dataset			**Realistic Dataset**			**Combined Dataset**		
	Precision	**Recall**	**F1-Score**	**Precision**	**Recall**	**F1-Score**	**Precision**	**Recall**	**F1-Score**
Macro Average	0.97	0.97	0.97	0.98	0.97	0.97	0.94	0.94	0.94
Weighted Average	0.97	0.97	0.97	0.98	0.98	0.98	0.94	0.94	0.94

Table 5: Classification report results for the validation dataset

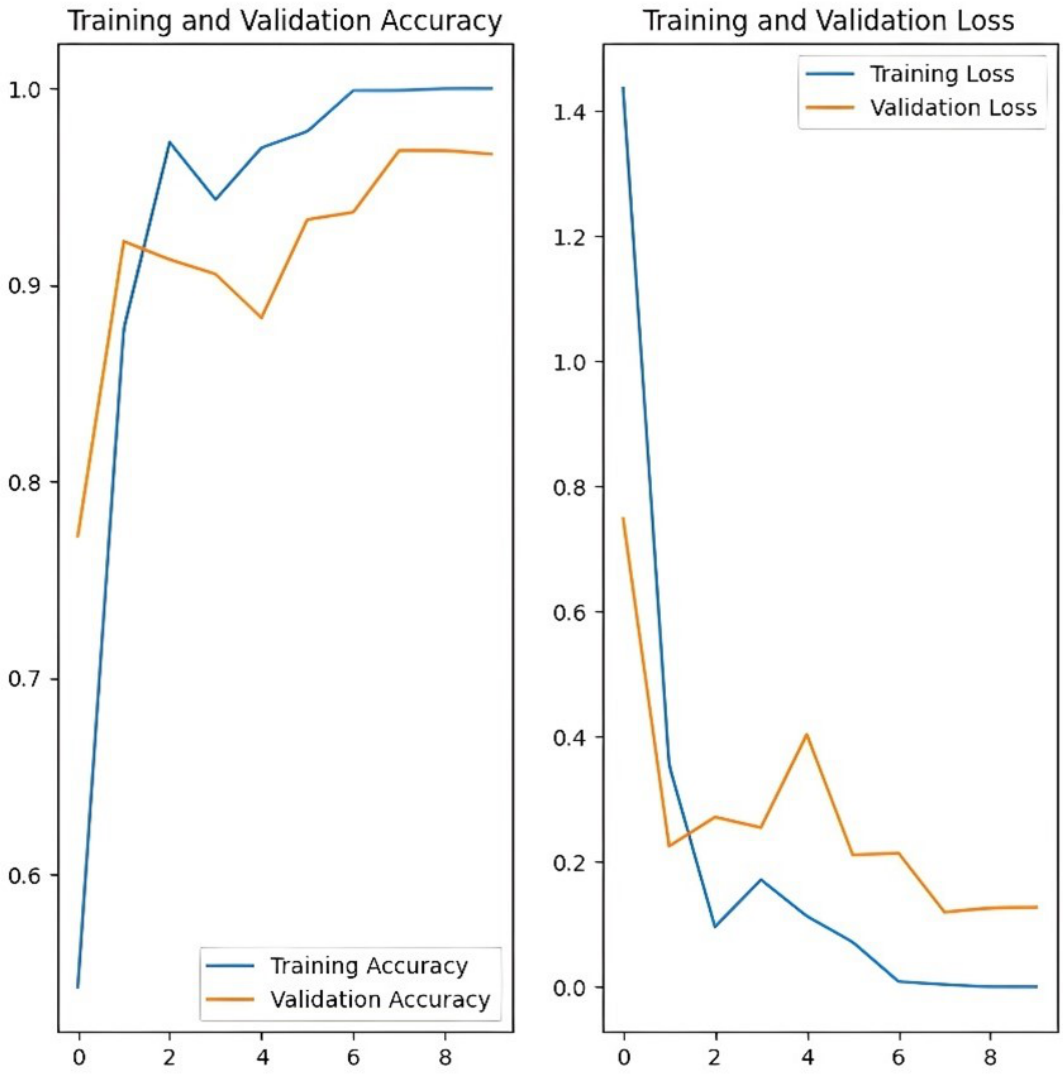

Figure 3: Accuracy and validation loss curves from the model trained on optimistic data over 10 epochs

Test 1 (Optimistic Dataset): The learning curve for the optimistic dataset in Figure 3 showed that training accuracy steadily increased and stabilised near 1.0, while validation accuracy fluctuated around 0.9. Validation loss initially decreased but later exhibited instability, suggesting overfitting.

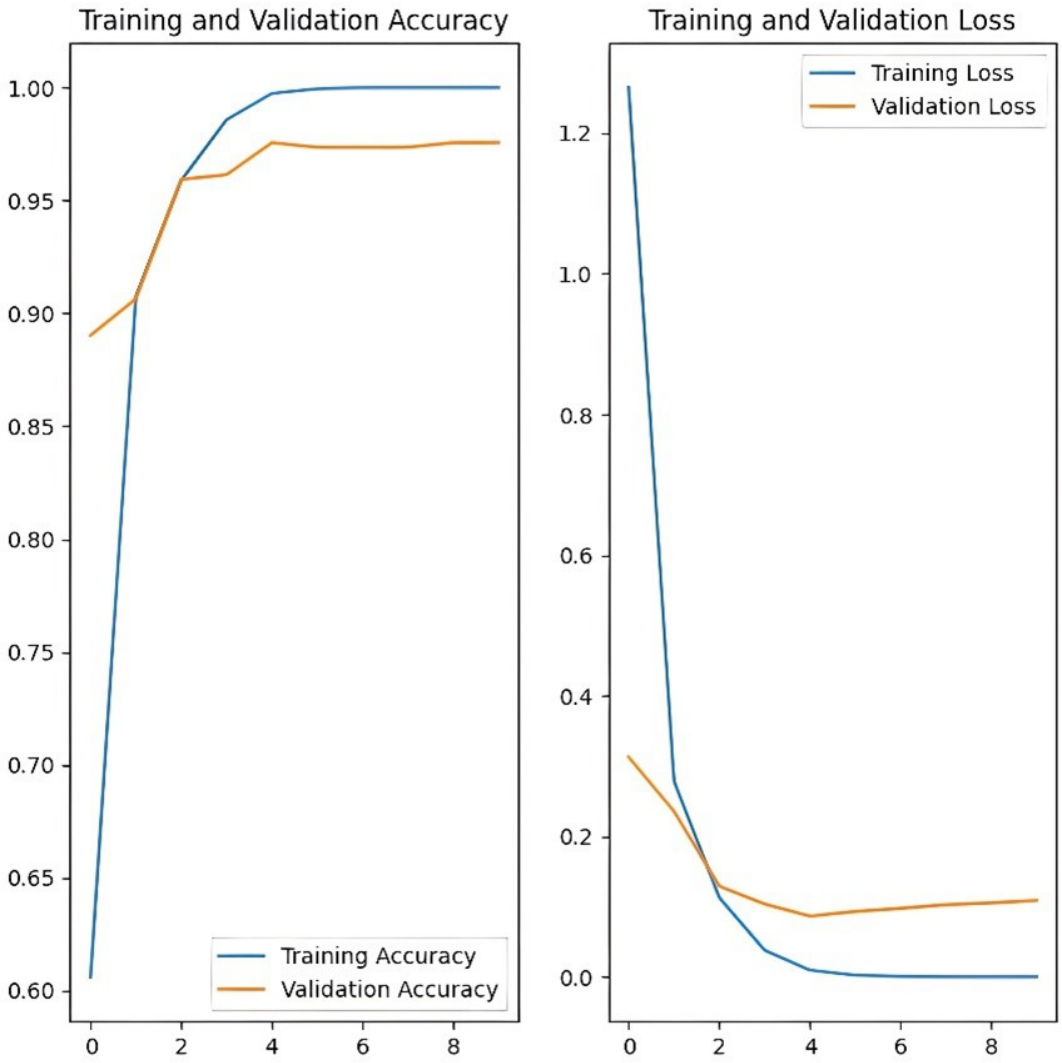

Figure 4: Accuracy and validation loss curves from the model trained on realistic data over 10 epochs

Test 2 (Realistic Dataset): Training accuracy rapidly increased and reached near-perfect levels by epoch 4, while validation accuracy stabilised around 0.95, as shown in Figure 4. The learning curve demonstrated a sharp decline in both training and validation loss, indicating effective learning with minimal overfitting.

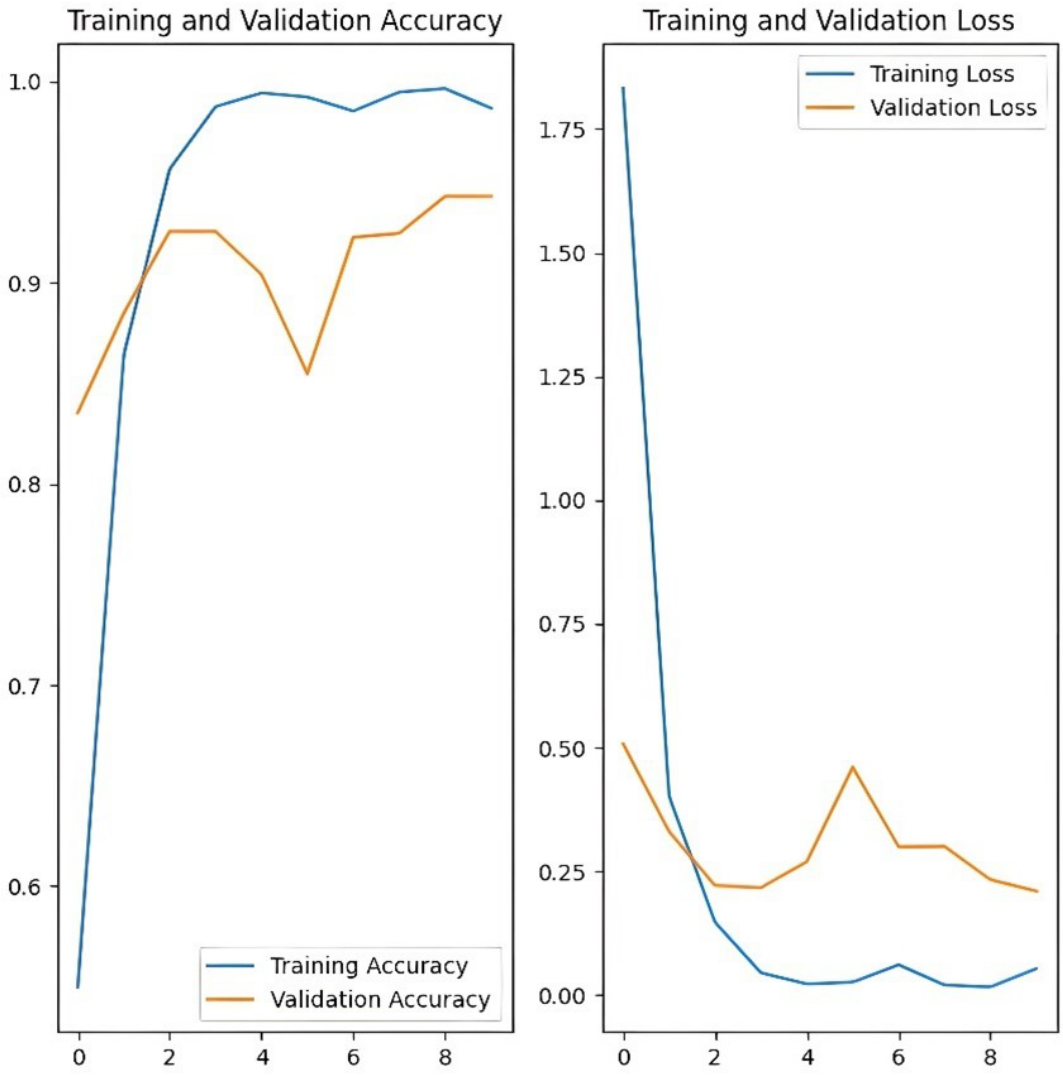

Figure 5: Accuracy and validation loss curves from the model trained on combined data over 10 epochs

Test 3 (Combined Dataset): Figure 5 shows that the training accuracy approached 1.0, but validation accuracy peaked at around 0.9 with fluctuations, suggesting instability in generalisation. Training loss significantly decreased, but validation loss fluctuated between 0.25 and 0.5, indicating potential overfitting during training.

All learning curves (Figures 3, 4 and 5) indicated signs of overfitting, particularly in the third or fourth training epoch. This suggests that the model was beginning to learn from noise within the dataset, leading to increased validation loss, as the CNN memorises irrelevant background patterns instead of generalisable features of the card. The optimistic and combined dataset models exhibited more pronounced fluctuations in validation accuracy and loss compared to the realistic dataset model, indicating that the noise present in the optimistic dataset was influencing the model's learning process. This could be attributed to reduced object boundary definition, which limited the learning of distinguishing features when predominantly white cards were placed against a uniform white background.

Figure 6: Samples of the Grad-CAM heatmaps indicating the regions of the image that have the most impact on the model's classification predictions

Given the autonomous feature extraction nature of deep-learning algorithms, it is challenging to determine which regions of an image the model relies on for classification predictions. To address this, a Gradient-Weighted Class Activation Map (Grad-CAM) was applied to the last convolutional layer of the CNN model to generate heatmaps for the testing images (see Figure 6). The heatmaps revealed that distinct colours and bold text regions significantly contributed to the model's classification process. However, some noise interference from the background was also highlighted in most testing images. While these background regions were relatively small compared to the foregrounded card area, they exhibited high intensity, indicating a

strong influence on predictions. Future work should investigate preprocessing methods, such as deterministic noise removal, to mitigate overfitting to dataset-specific noise, thereby improving the CNN's performance on varied and unseen data.

This experiment successfully refined the dataset selection process, confirming that the realistic dataset with a noisy background is best suited for NFC card classification. This reinforced the decision to use the CNN model trained on the realistic dataset for the final prototype implementation.

Experiment 3: Deployment and real-world evaluation

Following model experimentation, a refined CNN model trained on a more varied realistic dataset was deployed onto the Raspberry Pi 5 microcontroller for integration testing and performance evaluation. The objective of this experiment was to validate the project's real-world applicability by assessing *Clone Guard*'s ability to correctly and timely classify NFC access cards.

To maintain consistency across test scenarios, all manual tests were conducted in a controlled lighting environment using the Raspberry Pi Camera 2 Module. The test procedure involved presenting three different cards to the system's reader: a valid university student card (front and back tested separately), a blank white card and an invalid card. Each test was repeated ten times to account for potential variability in results due to card orientation. *Clone Guard*'s response was assessed by recording the following parameters: response time (measured from NFC card read to LED response), predicted classification and confidence score, and actual LED response.

System Performance			
Test Case	**Response Time (sec)**	**System Accuracy**	**Classification Accuracy**
Student Card (Front)	0.10	70%	90%
Student Card (Back)	0.09	70%	90%
Blank Card	0.09	90%	50%
Invalid Card	0.09	100%	90%

Table 6: Summary of system performance metrics

For valid university student cards with a confidence score of at least 75 per cent, the expected system response was to activate the green LED, whereas for invalid cards, the red LED was expected as demonstrated in the video here Reinvention Vol18 I2 video for articles. System accuracy for each test suite was calculated based on the number of correct responses.

Overall, these results confirm that *Clone Guard* performed with high accuracy and confidence across various card types. The findings strongly suggest that the system is viable for real-world deployment, demonstrating the effectiveness of deep-learning algorithms such as CNN in distinguishing between authentic and cloned NFC access cards. However, translating this proof-of-concept into a deployed solution introduces additional considerations beyond model accuracy, particularly around data volume, hardware and system efficiency.

The prototype demonstrated the feasibility of integrating ML into an NFC access system, but

several challenges remain before real-world deployment. Most notably, the training dataset was relatively limited in size and diversity, which restricts model robustness under varied conditions. To address this, the NFC-camera system could be deployed without the ML component to collect a larger and more representative dataset before model training. From a hardware perspective, the MFRC522 reader and Raspberry Pi Camera Module 2 were cost-effective selections for prototyping but would likely require upgrading for deployment. More robust NFC readers and higher-resolution cameras could improve reliability and image quality. Additionally, energy consumption was not prioritised in this study, and continuous camera operation combined with real-time ML inference introduces power demands beyond those of conventional NFC systems. Lightweight ML models or specialised microcontrollers with integrated AI acceleration should be explored to address energy concerns. While this work demonstrates technical feasibility, practical deployment will require refinements in datasets, preprocessing, hardware selection and energy efficiency to balance security benefits with system scalability.

Conclusion

This research evaluated the effectiveness of ML algorithms in distinguishing the physical features of NFC access cards, aiming to strengthen NFC access control systems against cloned cards. Experiments demonstrated that deep learning, specifically CNN, can confidently classify unique university student cards among visually similar NFC cards. Further quantitative results identified that training a CNN on a realistic, **noisy dataset** yielded optimal performance, likely the result of more distinct object boundaries between the cards and background. The study further validated real-world applicability by designing and integrating an end-to-end system capable of capturing card scans and processing card features to determine access eligibility.

Despite these promising results, limitations were observed. Model predictions were occasionally inconsistent due to background noise, potentially the result of the relatively small dataset and the minimal preprocessing applied prior to model training. Future work should explore larger and more varied datasets, along with deterministic noise removal or to enhance classification accuracy and generalisability.

Further optimisation is necessary to enhance *Clone Guard's* performance and readiness for large-scale deployment. Future efforts should focus on improving the classification model's learning and predictive abilities. Hardware limitations and real-time inference requirements of the current system present scalability challenges. For more practical deployment, a purpose-built device with specialised hardware, potentially featuring a card slot for controlled image capture, could significantly improve both usability and system performance.

Overall, this research introduces a novel image-based approach to detecting cloned NFC cards and provides a working prototype that validates the feasibility of a wireless, ML-driven access control system. With targeted refinements, *Clone Guard* has the potential to evolve into a scalable, secure solution for NFC access protection, laying the groundwork for future advancements in secure access control technologies.

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List of illustrations

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Appendix A

Class labels used in Experiment 1 and 2

Class	Description
UCBack	Back side of the University of Canberra (UC) student card, containing a barcode, contact information and text.
UCFront	Front side of the UC student card, showing the university logo, student profile photo and identifying details.
BackOther	Back side of other invalid cards displaying barcodes, terms and conditions, or minimal text.
Blank	Completely blank card, with no visible text, images or designs.
FrontColour	Front side of generic membership or loyalty cards, typically featuring coloured graphics, branding or text but not belonging to UC.

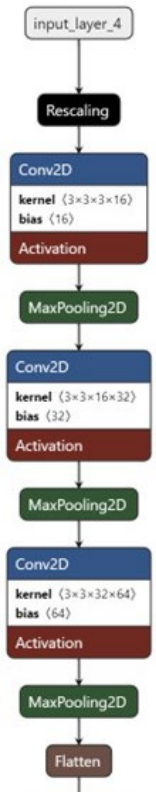
FrontDL	Front side of a driver's licence, displaying personal details, photo and official licence information.
FrontOther	Front side of other invalid cards showing branding, logos or designs.
BackColour	Back side of generic membership or loyalty cards, usually including a barcode, magnetic strip or terms and conditions.
BackDL	Back side of a driver's licence, containing text, barcodes and security features.

Appendix B

Refined class labels used in the deployed model (Experiment 3)

Class	**Description**
ValidBack	Back side of the University of Canberra (UC) student card, typically containing a barcode, contact information and text.
ValidFront	Front side of the UC student card, showing the university logo, student profile photo and identifying details.
InvalidFront	
InvalidBack	Back side of blank and generic membership cards, usually including a barcode, magnetic strip or terms and conditions.

Appendix C



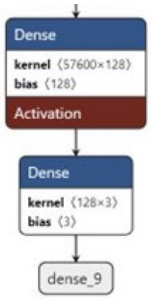


Figure 7: The CNN model architecture used in this research

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Glossary

Near-Field Communication: Short-range wireless technology that enables data exchange between devices

Machine learning: A subset of artificial intelligence that enables computers to learn from data, identify patterns and make decisions with minimal human intervention

Random forest algorithm: A machine learning method that combines multiple decision trees to make more accurate and stable predictions

Image-based classification approach: A technique that uses images to train models to recognise and categorise visual features

Design science research: A research method focused on prototyping practical solutions to solve real-world problems while contributing to scientific knowledge

Multi-class approach: A type of classification where the model learns to distinguish between three or more categories

Overfitting: When a model learns patterns that are too specific to the training data, performing well on it but poorly on new, unseen data

Heatmap visualisations: Graphical display that use colour intensity to show where a model focuses most when making decisions

Classification report: A performance evaluation metric for classification models that provides key statistics such as precision, recall and F1-score for each class in a dataset

Confusion matrix: A visual summary of the model's correct and incorrect predictions

Precision: Percentage of positive instances out of the total predicted positive instances

Recall: Percentage of positive instances out of the total real positive instances

F1-score: The mean of precision and recall values, providing a single metric to evaluate the performance of a classification model

Deep learning: A subset of machine learning that uses artificial neural networks with multiple layers to model complex patterns and representations in large datasets.

Fixed random seed: A predefined number used to control random processes in experiments so that results can be exactly reproduced each time

Hyperparameter: A setting chosen before training a model that influences how well the model learns from data

Noisy dataset: In the context of this research, a collection of images with cluttered backgrounds used to make the model more robust to real-world variation

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Access to Information and Support for LGBTQI+ People Seeking Asylum:

A Qualitative Exploration of Coventry's Asylum Accommodation

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Abstract

Both asylum seekers and LGBTQI+ people systemically lack access to information; in the context of the British asylum system, intersections and interactions between being LGBTQI+ and seeking asylum aggravate this insufficiency. This research project is unique in its exploration of the effects of the hostile asylum accommodation environment on LGBTQI+ people's access to information through the case study of Coventry's immigration accommodation. The research question 'What is the nature of LGBTQI+ asylum seekers' access to information and support in the context of Coventry's immigration accommodation?' was explored through interviews and focus groups with local LGBTQI+ people seeking asylum. The findings show that participants mainly accessed information through government-funded charities and accommodation staff, and that they had limited access to services specifically developed for LGBTQI+ people. They faced violence in the asylum accommodation, which translated into isolation and fear of revealing their sexual orientations and/or gender identities in order to request specialised information from housing staff. The fear was aggravated by staff inaction, which led to participants feeling discriminated against, and which further reduced their attempts to request support. This created a vicious cycle, in which LGBTQI+ people seeking asylum have continuously less access to information, which illustrates a systemic unpreparedness in the British asylum system to support this group.

Keywords: Asylum Seekers' Human Rights, Access to Information, Queer Studies and Migration, Development Studies

Introduction

Amid continuous implementation of harsh immigration policies that seek to control and deport those looking to obtain **refugee** status in the UK or '**asylum seekers**', people seeking asylum on the grounds of sexual

orientation and/or gender identity must navigate this hostile environment to fulfil a two-fold task: they must prove to the Home Office first that they are **LGBTQI+** and second that this has led them to be persecuted in their home countries (Ward, 2018; Heimer, 2019; UNHCR, n.d.). Information about how to access support, such as housing, finances, solicitors and healthcare, is essential to enable successful navigation through the asylum system.

The aim of this research project was to understand if the sources that LGBTQI+ people seeking asylum use to access information provide them with the support they need, and how this interacts with the violence and discrimination they face in asylum accommodation. Thus, the following research question was explored: 'What is the nature of LGBTQI+ asylum seekers' access to information and support in the context of Coventry's **immigration accommodation**?'

Although there is a growing field of literature on LGBTQI+ asylum seekers' experiences in **immigration detention centres**, their access to information in immigration accommodation facilities has not yet been studied in depth. This research project contributes to filling this gap by exploring the case study of the city with the most people seeking asylum per inhabitant in the West Midlands: Coventry (Sturge, 2024).

Two focus groups and five interviews with a total of twelve participants were conducted and thematically analysed to explore access to information in three asylum accommodation types: hotels, shared housing and living with friends. Findings show that the fear of revealing themselves as LGBTQI+ due to violence in immigration accommodation and staff inaction led participants to avoid asking for the information and support they required, revealing a systemic lack of attention towards LGBTQI+ people within the asylum system.

Literature review

LGBTQI+ people in the British asylum system

A perspective of homonationalism

Over the past decade, the UK has seen a simultaneous advancement of LGBTQI+ legislation (**Marriage (Same Sex Couples) Act 2013**) and an imposition of harsh immigration policies (**Nationality and Borders Act 2022**; **Illegal Migration Act 2023**). Heimer (2019) argues that this

exemplifies British 'Homonationalism', a term that Puar (2013) developed to describe the usage of increased legal and consumer LGBTQI+ rights to maintain a progressive international image while implementing policies that seek further surveillance, detention and deportation of the asylum seeker and refugee community.

Heimer (2019) finds that asylum claims on the grounds of sexual orientation and/or gender identity (SOGI) in the UK are part of a homonationalist attempt by the country to demonstrate itself as a selfless defender of non-Western LGBTQI+ people from their own 'backward homophobic cultures' (Heimer, 2019: 178). Lewis (2021) argues that the asylum system demands that asylum seekers behave as 'good sexual citizens' (2021: 751) by portraying identities, visibilities and consumption that reproduce Western conceptions of being LGBTQI+. When they are unable to do this due to racist preconceptions, poverty, detention and lack of access to solicitors, they then must act as 'good deportees' (2021: 760) by complying with their own deportation. This hostile environment is reinforced through the perpetration of violence and discrimination by other detainees and staff while in detention (Stonewall and UKLGIG, 2016).

LGBTQI+ people in the UK's immigration detention and shared accommodation

LGBTQI+ people struggle to reveal their SOGI out of fear of facing discrimination and harassment in immigration detention (Harvey, 2023; Lewis, 2021; Stonewall and UKLGIG, 2016; UKLGIG, 2018). This fear is not unfounded as research has shown that LGBTQI+ people in British immigration detention encounter discrimination, harassment and abuse perpetuated by other detainees and staff (Lewis, 2021; Harvey, 2023; Stonewall and UKLGIG, 2016; UKLGIG, 2018). Stonewall and UKLGIG (2016) found that LGBTQI+ people were hesitant to speak to staff about their needs, and Harvey's (2023) research shows that staff offer them mixed responses of support, inaction or discrimination. Fear of having their SOGI revealed and the constant presence of other detainees and staff pose an obstacle to communication with solicitors and other people required to provide the information they need to support their asylum claims (UKLGIG, 2018). Experiences in detention have long-lasting mental health impacts for LGBTQI+ people seeking asylum: Ward (2018) highlights that the British asylum system contributes to asylum seekers' retraumatisation, exacerbating their PTSD symptoms.

Despite the lack of literature on LGBTQI+ experiences in British asylum accommodation, there is evidence of similarities to immigration detention. News outlets have reported on LGBTQI+ people's experiences in British asylum accommodation, which includes bullying and abuse (Barker, 2021; Lyons, 2018; Stroude, 2023; Taylor, 2023) and staff inaction when reporting abuse (Hearst, 2023). Studies conducted in Europe and Canada have outlined similar discrimination and harassment within immigration accommodation towards LGBTQI+ people (Abramovich *et al*., 2020; FRA, 2017; Lee and Brotman, 2011).

The Women and Equalities Parliamentary Committee (2023) recently released a report highlighting that LGBTQI+ people in asylum face verbal and physical homophobic harassment and live in constant fear of their SOGI being revealed. This fear keeps LGBTQI+ people from contacting support groups and reporting harassment, with their complaints often being dismissed by accommodation staff when filed (2023). The report demands that LGBTQI+ people, families and children be placed in separate accommodation (2023).

Existing research therefore indicates that LGBTQI+ people face harsh conditions in the UK's immigration accommodation and immigration detention.

Access to information

Information is essential for people seeking asylum to access the timely support they require to fulfil their legal, education, health and housing needs (Abdi *et al*., 2023; Oduntan and Ruthven, 2020). Oduntan and Ruthven (2019) describe the asylum journey as 'survival of the informed', whereby those with more information can navigate the system better than others. In a later study, Oduntan and Ruthven (2020) split information sources accessed by refugees and asylum seekers into two main categories: formal (includes caseworkers, social workers and solicitors) and informal (includes friends and family). They also found that service providers did not consistently provide information to asylum seekers. Others have shown that refugees and asylum seekers did not know what questions to ask and struggled to access appropriate information at the time that it was needed (Kainat *et al*., 2022). Bronstein (2017) argues that language abilities are central to asylum seekers' access to information, indicating that the information format is essential in addition to its source.

The literature shows that LGBTQI+ people lack access to information on

several fronts, such as in school curriculums (Kosciw *et al*., 2020; Russell *et al*., 2021), incarceration (Austin *et al*., 2020) and health (Taylor *et al*., 2019). Taylor *et al*. (2019), for example, find that LGBTQI+ cancer patients lack information provided for them both online and offline, leading to higher cancer mortality rates among this group. The consistency of these studies' findings indicates that LGBTQI+ people systemically lack access to information and thus face additional intersectional barriers to securing support.

Methods

To explore the linkage between lack of access to information and the hostile environment encountered by LGBTQI+ people seeking asylum in the UK, this research project posed the question 'What is the nature of LGBTQI+ asylum seekers' access to information and support in the context of Coventry's immigration accommodation?'

To answer the research question, two focus groups and five semi-structured interviews were conducted with twelve LGBTQI+ asylum seekers and refugees. Respondents were identified through **convenience sampling**, which implies that participant recruitment was not randomised and their accessibility was prioritised. This is a common practice in LGBTQI+ asylum research, given frequent challenges in gaining participants' trust (Nematy *et al*., 2023).

Focus groups (FG) allow researchers to observe the interactions between people with similar experiences and qualities (Lewis-Beck *et al*., 2004). They were conducted in this case to tackle the experiences that participants had in different immigration accommodation types: immigration hotels – an accommodation with shared bedrooms, bathrooms and eating facilities; Serco Housing – a shared flat with four to eight inhabitants; and living with friends – often sleeping on their couches and only staying for short periods of time. Due to a limited number of people willing to take part in the focus groups, the participants were divided into two: the first group (FG1) was composed of seven participants who lived or had lived in immigration hotels and the second (FG2) had six participants, three of whom lived with friends, two in Serco Housing and one in a charity-provided accommodation. Seven of the participants revealed that they had lived in more than one type of immigration accommodation, and one participant was present in both FGs, since they had lived in immigration hotels before being moved to Serco Housing. Three participants made it known that they were living in Birmingham and

the other nine were living in Coventry. All had regular contact with Coventry and its immigration services. The FGs allowed for participants to familiarise themselves with the research before being invited to participate in interviews.

Four out of five of the interviews were conducted with participants of the FGs. Semi-structured interviews were chosen as a research method because, given the gap in the literature, the flexibility of this method allowed participants to include unexpected elements that they found relevant (Kallio *et al*., 2016). Researchers have overwhelmingly used semi-structured interviews to explore asylum seekers' experiences and access to information (Abdi *et al*., 2023; Kainat *et al*., 2022; Lee and Brotman, 2011; Nematy *et al*., 2023; Oduntan and Ruthven, 2020; Stonewall and UKLGIG, 2016). Four of the interviewees were in the process of seeking asylum and had SOGI-based claims: one was living in an immigration hotel, two in Serco Housing and one in charity accommodation. The last participant was a refugee living in private accommodation in Coventry, who had previously lived in G4S Housing – the current equivalent to Serco Housing.

Given the legal and financial constraints faced by people seeking asylum in the UK (Right to Remain, 2024; Visas and Immigration, 2024), they were considered in this research as vulnerable adults, requiring a rigorous ethical procedure undertaken through the University of Warwick to ensure their safety and wellbeing. The interviews and FGs took place in familiar and safe environments to ensure participants were secure and felt safe to share their experiences. The consent process was explained to the participants multiple times and was translated into French to accommodate those who were not proficient in English. It was explained to them that no information would be collected or shared that was not relevant to the research, and pseudonyms would be used for all participants. Participants were given two weeks after the FGs to opt-out and the researcher returned to the group after each FG to confirm that members were still comfortable sharing their experiences. The interviews and FGs were recorded on a secure wired device and later transcribed by the researcher.

After collection, the research was analysed following Braun and Clarke's (2021) guide to thematic analysis:

1. Familiarisation with the research through listening and transcribing recordings
2. Data coding through segmenting interviews and FGs into common topics addressed by different participants
3. Development of initial themes through finding patterns across the interviews

and FGs
4. Reviewing and restructuring overarching themes and sub-themes
5. Defining and naming themes
6. Write-up and final adjustments

The main themes identified through the thematic analysis were:

- Information acquiring through NGOs and Serco
- Harassment, abuse and discrimination – within the asylum community and among staff
- Fear of revealing one's SOGI
- Fear of asking for support
- Disillusion with the British asylum system and homonationalism
- Potential solutions

Findings were compared to the literature and analysed through the lens of homonationalism, which provided a framework for exploring the interactions between state power, sexual orientation, gender identity, race and immigration status.

Findings

Sources of information

The main sources accessed to request information or support were as follows: nine participants stated they consulted two charities funded by the government that supported refugees and asylum seekers nationally and locally: Migrant Help (MH) (Migrant Help, n.d.) and the Coventry Refugee and Migrant Centre (CRMC, n.d.). Eight participants referred to Serco staff employed by the hotels and Serco Housing, and four chose to search for their needs online. Those who lived in the hotels mainly consulted the Serco staff, while those living in Serco Housing, with friends or with charities referred to CRMC and MH. Four participants mentioned language barriers and one participant named it as his main obstacle in navigating the asylum system.

Participants reported struggling to find sources of information and support that catered to their circumstances as LGBTQI+ individuals. Cristina resorted to online sources after being unable to fulfil her information needs through CRMC or MH, only to find they were also incomplete: 'you need to go online and it's not everything that is online,' she stated. FG1 conversations highlighted that LGBTQI+ hotel residents were provided with the same services accessible to all – Eske highlighted that 'if you have specific LGBT issues, they won't be able to help you'. Additionally, two participants stated they had been unaware of the possibility of claiming asylum before moving to the UK. Both had come to

the UK for work purposes initially and claimed asylum when they realised they were not safe in their home countries. These participants particularly struggled to access information and support when they first claimed asylum, explaining that they did not know how or where to request it.

Several participants expressed feeling afraid of asking for LGBTQI+ support from the CRMC, MH and Serco staff. Eske explained that she did not feel comfortable asking the staff for help: 'I had to search online where should I go to communicate with more people like me. I couldn't ask them.' In addition to depending on accommodation type, the sources of information chosen were impacted heavily by participants' fear of communicating their SOGI-related needs.

Fear of revealing their sexual orientations and gender identities

All 12 participants expressed that there were risks to revealing themselves as LGBTQI+ in their accommodation and only two stated they chose to speak openly about their SOGI. Eleven participants stated they avoided revealing their SOGI in their accommodation.

Homophobia in the asylum system

In FG1, participants' experiences of discrimination and harassment in the hotels were a primary reason for concealing their SOGI. Eske explained that her roommates 'would always talk bad about LGBT people, so I was not really comfortable sharing anything with them'. Participants who were living with friends also felt they were not able to reveal their SOGI to them and there was an added pressure of the possibility of becoming homeless if they were to find out. 'Literally you can't tell them,' said Gabriel, who later explained that 'they see you as the devil'. Blaine told FG2 about their experiences of living with a friend, who did not react well to their SOGI: 'They say that's not right, […] it was just not okay for me to stay there so I had to find another place […] they don't take that lightly once they find out your sexuality.' Blaine was homeless when this focus group took place, revealing the impact of this discrimination on his previous housing arrangements.

Participants expressed feeling isolated from their roommates and other hotel residents. Cristina said that people would avoid her in the cafeteria. Samira explained that 'they don't sit with you because they think you are dirty. You are LGBT, so you are dirty.' Samira compared the treatment they received publicly and privately:

> When you are in a public place like a canteen, they are not coming close to you, because people know you. But if they find you somewhere like in corridor, in toilet, in your room alone, then they grab you.

This was one of the several accounts of experiences with sexual harassment which primarily occurred in the immigration hotels. Miduna, a transgender woman, explained that due to her experiences of being harassed, she would isolate herself as much as possible:

> The guy was blocking me in the lift suddenly, with no reasons. Then I know they are trying to do something [sexual]. I also try to be silent, avoid everything. […] I try to be alone, eat alone.

When Cristina revealed her sexual orientation, a man began harassing her daily, which culminated in pushing her to inform the police. She was subsequently removed from the hotel and placed in Serco Housing, where she faced further difficulties in requesting support when needed due to a lack of contact with Serco staff.

Several participants expressed that the violence they faced made them feel that although they were in the UK, they remained in similar conditions that led them to flee their home countries. Miduna explained that she faced abuse and discrimination for her SOGI in her home country and added that 'the same thing is happening [in the UK], same stigma and discrimination. […] is not safe for us'. Seven participants thought a possible solution was to create separate accommodation dedicated only to LGBTQI+ people and their allies.

The consequence of being in this environment was hesitation to request information out of fear of having their SOGI unintentionally revealed. Eske described a particular moment in which she wanted to request different accommodation 'but then I decided against it because I didn't want to tell the hotel staff. And maybe I was scared that maybe they would tell other people, maybe it would get out.' Samira, who had attempted to promote an LGBTQI+ asylum seekers' support group at the asylum hotel, stated that people were too afraid to take the leaflets she was distributing. She remembered that even those who had taken one 'brought it back said, "No no no" like very loud, very obvious "No no no, I don't need it!"' This is evidence that participants' fear of being discovered as LGBTQI+ had a direct impact on their access to information or to access support.

Participants who lived in Serco Housing or with friends had similar problems, although this was alleviated by having more freedom to leave their accommodation. Gabriel explained that he would always make calls

about his SOGI-based asylum case while on walks to avoid revealing himself to his housemate. Fear of having their SOGI revealed and the violence this would attract was therefore a primary obstacle for participants in accessing the information and support they needed, especially for hotel residents.

Staff and service providers' inaction

Inaction from staff and service providers was another primary obstacle for participants to obtain the information and support they needed: almost all interviewees highlighted that, even if they gathered the courage to reveal their SOGIs, they would be met with 'deaf ears', as described by Blaine.

Serco staff's inaction was a central concern of hotel residents. Gray and Eske stated that if they spoke to Serco staff, they would 'listen but not do anything about it'. Several participants in FG1 told the group they had submitted requests to be put in a single room due to discrimination and lack of privacy, which were usually denied.

Additionally, reporting harassment once was not enough to warrant a response from the hotel staff. Gray described a hotel officer's reaction to his report of being sexually harassed and expressed frustration towards not being taken seriously:

> I am experiencing what this person is trying to show to me, licking his lips, doing things, talking to you all the time, showing all those weird [sexual] things. I reported to the [hotel] office and they were like 'Oh maybe he's just like that, he's just kind of stupid.'

Miduna faced unique frustrations in the hotel conditions due to her gender identity; even though she informed immigration staff that she identified as a woman upon arrival in the UK, she was repeatedly placed in men's accommodation. When she reported her roommate's discriminatory attitude, she recalled that the Serco staff answered: 'the guy is a very good guy. You stay with him.' Miduna explained how she felt about the hotel staff: 'They give more importance to other people, not LGBT people.' It was only after she called Migrant Help and explained her situation that she was given a single room.

Miduna's case was not isolated: solutions offered up by the staff were often reactive and only offered when participants were already in situations of high risk. Cristina and Gray explained that their concerns were only addressed after they had been harassed by other hotel residents. Despite expressing anger towards not being provided preventative

support, they both spoke positively about hotel staff members who had helped them.

All interviewees, particularly those living in Serco Housing or with friends, highlighted that the institutions responsible for caring for people seeking asylum in Coventry often did not help them. Cristina explained that when her financial support suddenly froze, she called Migrant Help for five days in a row and they told her to file a complaint: 'I'm telling you I haven't eaten for days, […] and you're telling me to file a complaint that's gonna take three weeks for them to do- to take action for it!' she recalled loudly and angrily.

Similar experiences occurred when participants interacted with the CRMC. Gabriel and Cristina referred to the organisation to access a solicitor. Gabriel recalls the answer he got: 'solicitors are saying that your case is too hard, so they can't handle'. Cristina also stated that '[the charity worker] said something about the Home Office calling him [solicitor] and they can no longer take on cases like that'. Gabriel explained that 'sometimes I feel like maybe because of my sexual orientation, that's why they don't want to help me'. These experiences illustrate a dominant pattern of inaction, which participants often saw as a form of discrimination.

Another primary source of feeling discriminated against was the participants' asylum interviews, which included interpreters using offensive language and interviewers disbelieving interviewees' statements about their SOGIs. Samira explained that interpreters often did not know appropriate LGBTQI+ terminology and would call them 'sissies'. Cristina stated that when she went to her screening interview, she was taken to a private room by an immigration officer, who asked her questions about her arrival in the UK and then proceeded to scream at her: 'This how you people come here and you're lying,' she recalled being told. She told FG2 that this was an experience of racism. 'When you are from Africa, when you are Black […] they always think we are lying,' said Magnus, who also stated this disbelief was a racist approach to LGBTQI+ asylum seekers.

Gabriel, Cristina and Blaine, who were all forced to live with friends at some time in their asylum processes, stated that this was caused by a lack of response from charities and the Home Office. 'I once reach out to them and it took them too long to respond to my request, so I got a friend who help me get a place to stay,' explained Blaine. Gabriel highlighted that living with friends created a vacuum in his information sources, since he

had no direct contact with any Serco officers that he would otherwise ask questions to.

Staff inaction led participants to feel as though they were asking for too much or causing trouble. When Gray's reports of harassment in the hotel were not being addressed, he said that he 'didn't want to be the one guy who keeps reporting people about his sexuality'. 'They were not really doing enough about it, then I might just keep quiet and suffer,' he said. Sacha added that 'the more you keep complaining about people, they start to think you're the problem', a statement which all the participants of FG1 proceeded to agree with. Sentiments of embarrassment and frustration towards constantly being required to beg for their basic needs were expressed by Gabriel and Cristina.

Participants had mixed feelings about the UK and the British asylum system. Three participants noted that they felt safe within the LGBTQI+ community in the UK. Cristina and Gabriel, on the other hand, stated that the only positive factor about the UK was that they were no longer being persecuted. Gabriel described the British asylum system: 'Everything is acting, it's like they're [immigration staff] acting in a movie.' '[The Home Office] play with our lives,' he added exasperatedly.

The sentiments that the British asylum system was unjust and pervaded by discrimination and staff inaction dominated the discussion in the focus groups and interviews. Staff inaction was a significant barrier to gaining access to support from solicitors, healthcare workers and Serco staff. Inaction was often interpreted as racism or homophobia, which exacerbated participants' hesitation to approach them when they required support.

Discussion

The abuse, harassment and discrimination experienced by LGBTQI+ people in Coventry's asylum accommodation were in line with descriptions by news outlets and the Women and Equalities Parliamentary Committee (2023), and shared similarities with those found in the literature on British immigration detention (Harvey, 2023; Lewis, 2021; Stonewall and UKLGIG, 2016; UKLGIG, 2018). This and the subsequent pressures to conceal their SOGI were particularly experienced by participants living in hotels, since they were constantly surrounded by people who might pose a threat to them.

The fear of revealing their SOGI was aggravated by inaction from MH, the CRMC and Serco staff, whom participants were dependent on for information. This dependence was potentially aggravated by their difficulties obtaining solicitors and their isolation from friends and family, information sources within the asylum system described as central by Oduntan and Ruthven's (2020). Despite MH, the CRMC and Serco being sought out as the main sources of information, they often behaved inactively, which created barriers to accessing information and was interpreted as homophobia and racism by participants. This inaction particularly impacted residents living in Serco Housing, who had less direct contact with immigration staff. Although it is unclear whether lack of preparedness and/or homophobic and racist beliefs were the drivers of staff inaction, this environment saturated by feelings of hopelessness, mistrust and fear suggests that there is a systemic marginalisation of LGBTQI+ people seeking asylum in the UK. This mistrust might in turn lead staff to be uninformed and unaware of the scale of the barriers imposed onto LGBTQI+ people in the asylum system, potentially reducing the chances of structures/processes to protect them being put into place.

Experiences of obtaining support were dependent on occasional moments of staff going out of their way to help participants, who were often already at risk of violence or homelessness when said assistance was offered. Moments of risk were often linked to participants revealing or having their SOGI revealed. This created a paradoxical dynamic in which participants would suffer less harassment and discrimination if they concealed their SOGI, and yet they could only access the support they required if they did the opposite. Findings are therefore not aligned with Oduntan and Ruthven's (2019) 'survival of the informed', instead simultaneously indicating a 'survival of the hidden' with regards to maintaining one's physical safety, and a 'survival of the seen' with regards to obtaining support and avoiding one's claim being rejected.

The consequence of living in this environment was a vicious cycle of victimisation, isolation and lack of support, which, in addition to indicating a system unprepared to receive LGBTQI+ people, could be evidence of the victim-blaming-centred structure of the asylum system. Although the UK portrays itself as a protector of LGBTQI+ people (Heimer, 2019), the findings of this research indicate that this protection is often not available and occasionally withheld from them, putting the British asylum system in a dual position of protector and aggressor.

The structural lack of information coupled with continuous violence and threat faced by LGBTQI+ people is indicative of the homonationalist and dehumanising structures of the British asylum system. Participants expressed strong feelings of disappointment towards, and sometimes betrayal by, the British Home Office. Although they initially believed that claiming asylum in the UK would protect them, this was not reflected in their practical experiences. This aligns with Heimer's (2019) argument that British LGBTQI+ rights advancements have not been incorporated into the asylum system and are used as a homonationalist strategy to appear progressive. The brutality of asylum accommodation and lack of access to information and support created a hostile environment; although the UK might embrace some of the LGBTQI+ community, research findings indicate that LGBTQI+ asylum seekers are not welcome.

To address the obstacles faced by LGBTQI+ people living in Coventry's immigration accommodation, they should be provided with unique accommodation arrangements, provisionally through single rooms in the hotels and in the medium-term through giving asylum seekers the option to stay in an LGBTQI+-only housing. LGBTQI+ people would also benefit from having an officer specialised in their needs, as well as making LGBTQI+ training mandatory for all Serco staff. Above all, the British asylum system requires systemic changes that put an end to the homonationalist structures that currently pervade it. This would require further research, especially with asylum seekers who do not have SOGI-based asylum claims and with immigration staff, to understand their perspectives.

The findings of this research are limited due to the convenience sampling technique which was employed and the limited number of research participants. Most interviewees had SOGI-based asylum claims, which may imply they must be more open about their SOGI to obtain specialised information and support, potentially making them more vulnerable to harassment and violence. Additionally, only four participants did not speak English fluently and, given Bronstein's (2017) findings of language as a central barrier to obtaining information in the asylum system, this group might over-represent those who have facilitated access to information.

Conclusion

The vicious cycle of violence and fear of revealing their sexual orientations and/or gender identities is central to LGBTQI+ people's lack of access to

information in Coventry's immigration accommodation. The discrimination, harassment and abuse that participants endured inside the asylum community, coupled with staff inaction, demonstrate a systemic lack of preparedness to accommodate this population in Coventry. This is an indication of the existence of homonationalist tendencies within the UK, whereby the British asylum system does not deliver on its promises to protect LGBTQI+ asylum seekers and retains them in a state of constant fear. The provision of Serco Housing specifically designated towards LGBTQI+ people seeking asylum is necessary to alleviate their immediate needs.

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Glossary

Asylum seeker: A person who is in the process of applying for refugee status in a specific country. This application can be made on several grounds, including political persecution, religious persecution and persecution due to sexual orientation and/or gender identity.

Convenience sampling: A non-probability method that involves sampling research participants who are most accessible to the researcher (Stratton, 2021). In this research project, participants self-selected if they wanted to participate. This method is often used with research participants of vulnerable communities because it allows for the establishment of trust between participants and the researcher.

Illegal Migration Act 2023: Act that determined that anyone arriving in the UK through irregular routes, such as small boat crossings, would not be able to claim asylum, regardless of their protection needs (Illegal Migration Act 2023). Many organisations, such as Freedom from Torture, have argued that this act breaches international law, since it pulled back on commitments such as not sending people to countries where they could

be at risk of persecution (Freedom from Torture, 2023).

Immigration accommodation: Lodgings provided to asylum seekers by the Home Office while they are in the process of trying to obtain their refugee statuses.

Immigration detention centres: Detention centres specifically dedicated to asylum seekers, who can be detained at any stage of their claim. Asylum seekers are often detained upon arrival in the UK and also in the case that they are imminently to be deported from the country.

LGBTQI+: Umbrella term that describes people who experience sexual orientations and/or gender identities that are not heteronormative. This term was used throughout this research paper because it was the preferred terminology employed by research participants.

Marriage (Same Sex Couples) Act 2013: Act that extended the right to marriage to LGBTQI+ couples in England and Wales (Marriage (Same Sex Couples) Act 2013)

Nationality and Borders Act 2022: Act that split asylum seekers into two groups: admissible and inadmissible. An asylum seeker is considered inadmissible when they (1) arrive in the UK through irregular routes, (2) travel through a 'safe third country' before arriving in the UK, or (3) are from an EU country. An inadmissible asylum seeker can be removed to a country considered 'safe' by the British government (Nationality and Borders Act 2022). One example of how this act was taken advantage of was the Safety of Rwanda Act of 2024, an agreement between the British and Rwandan governments which planned on removing inadmissible asylum seekers to Rwanda (Safety of Rwanda Act 2024).

Refugee: A person who has applied for and subsequently been granted leave to remain in a specific country, gaining refugee status.

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Critical Reflections

Fraser Logan, University of Warwick

This edition introduces a new form of *Reinvention* article: Critical Reflections. In academic publishing, the author is all too often excluded. Academic conventions favour impartial prose. The first-person pronoun is discouraged, while lived experiences are concealed – despite the fact that research is always shaped by the person conducting it. When highly polished yet impersonal text can be produced at the click of a button, there is a need for publications which make space for human voices and relatable perspectives. These Critical Reflections reintroduce the author back into the publication landscape, creating space for students not only to present their research, but also to reflect on their relationship to their work and their identity as budding researchers.

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Testing the Limits. Can Nitrate Levels be Used to Safeguard the Health of UK Rivers? The Critical Reflection of an Undergraduate's Introduction to Independent Research

Federico Fidel White, University of Warwick

Abstract

The novelty of independent research is always a memorable experience, although never for the reasons expected. The responsibility of designing and executing an original project; the uncertainty of having to cope with issues as and when they arise. While I can attest to this being a positively enriching experience, it was certainly not without its drawbacks. Since the majority of these were a product of my shifting priorities, this came to define my project. Akin to a trial by fire at times, I thus attained a better understanding of the realistic expectations that ought to come with carrying out research, at any level, alongside the strengthening of my resilience to setbacks – although it did not feel as such at the time. Met with unfavourable circumstances, I nevertheless produced a comprehensive academic poster that has since allowed me to present at multiple conferences. Furthermore, I have taken my experience here and the desire to undertake research onto the next project and will continue to do so going forward.

Keywords: Nitrate pollution, riverfly abundance, safeguarding UK rivers, UK river health.

Introduction

During the summer of 2024, I undertook a research project to investigate the influence of **nitrates** on the **health** of UK rivers, with a focus on examining the need for introducing environmentally focused nitrate limits to safeguard river biodiversity. Funded through the University of Warwick's Undergraduate Research Support Scheme (URSS), this study was my introduction to the satisfaction and struggles that come with carrying out original research (University of Warwick, 2025). This critical reflection will therefore, in the style of Gibbs' Reflective Cycle, review my candid experience of the project: from the initial unfamiliarity of my academic independence to grappling with issues I could feasibly address and recognising those I could not (Gibbs, 1988). Although I could identify a plethora of strengths and limitations with how I approached and executed this project, it would be more fitting to summarise this evaluation as a recognition of the 'shifting priorities' that come with navigating independent research.

Plotting of pollution

To better understand the scale of the issue I hoped to investigate, I set about mapping the major sources of pollution affecting each of my sample rivers: the River Wye, Great Ouse and Dart. These rivers were categorised by **intensive farming units**, sewage treatment works and settlements with populations exceeding 2000 people, the latter signifying risk of **urban diffuse pollution**. This would enable the characterisation and assessment of pollution at each site I sampled, which I planned on incorporating with a water quality index (WQI) – which uses several **physicochemical** parameters of water quality to evaluate surface water quality, including nitrate (Uddin *et al.*, 2021).

The mapping stage of my study took place prior to doing any of my own sampling, and hence became the first drawback. Firstly, I planned on using ArcGIS Pro as my preferred mapping software, due to being able to overlap multiple layers of data with both spatial and temporal properties, helping to produce a comprehensive output (Esri, 2025a). Unfortunately, given that I work on a Mac, I soon learnt ArcGIS Pro does not natively support MacOS and required running the programme within a Windows environment on my Mac

(Esri, 2025b). Despite the help of the University of Warwick's IT Services team to overcome this issue, I soon came across a worse problem.

Further reading into WQIs led me to discover the minimum number of physicochemical parameters I required would be four, not the two I was investigating, while most widely used models utilised between eight and eleven of these parameters (Uddin *et al.*, 2021). To adhere to my budget and still produce a sufficient body of data from across my sample rivers, I realised the importance of my mapping work would have to be sidelined. Given the number of hours I had committed to mapping, I was frustrated to say the least. Fortunately, my work was not completely wasted, as it remained effective in illustrating the magnitude of **anthropogenic pressures** facing our rivers when presenting my final output, while elsewhere in the study, I could support this with statistical outputs. The balance between qualitative and quantitative analysis proved most effective in disseminating my findings to interdisciplinary audiences.

This experience certainly helped me identify a disconnect between the planning and budgeting aspects of my research and what is analytically achievable. As such, I hope to be more realistic, in terms of project constraints, whether budget, timing or otherwise, when planning and executing future research projects.

Grappling with government data

While I continued with mapping, my preparations also involved studying the Environment Agency's (EA) Ecology & Fish Data Explorer and Water Quality Data Archive, and where data was unavailable, having to submit several Environmental Information Regulations (EIR) requests to both the EA and Natural Resource Wales (NRW) (Environment Agency, 2025a; Environment Agency, 2025b).

The aim of this was to obtain historical ecological and physicochemical data for each of my sample rivers to compare my to-be-collected data to long-term trends in pollution and determine if my data was expected or noticeably

different to historical figures. Although the process felt cumbersome at times – only helping confirm my prior concerns regarding engagements with government organisations – the few individuals I did speak with were fortunately very accommodating in processing my EIRs and forwarding them to the relevant offices for my sample rivers.

Difficulty instead came from the archived data often containing missing entries, at times across several years; this effectively prevented me from accurately charting trends in river health. Although a useful experience, and one that ought to be beneficial for any future projects, if at least to temper my expectations of EIR requests, this forced me to alter the emphasis of my project. Initially designed to consider both spatial and temporal analytical directions, the emphasis was streamlined to a purely spatial comparison. While I did not recognise this at the time – I suppose that as the issue of river pollution and its management has, in recent years, only become more pertinent to the interests of the public – it may have been more appropriate to begin as a spatial analysis.

Hereafter, I ought to better scrutinise the aims of my projects, to identify the most appropriate means of answering my objectives without needlessly wasting time and other resources on less effective strategies.

Sample selection and access

Much of my data collection consisted of nitrate testing, a determinant of water quality measured using a **photometer**, and invertebrate sampling with a focus on **riverfly** abundance – a useful indicator of environmental health. While selecting possible sample sites along each river, I thus prioritised sampling depth as the main factor governing my decision, with site depths above what would allow for kick sampling – the disturbance of substrate from the riverbed to collect dislodged invertebrates (Field Studies Council, *nd*).

Although I primarily relied on resources such as River Levels UK, I initially remained determined to not waste the data I had obtained through my EIR requests and compare my results to government data for the years available

(River Levels, 2025). Attempts to align my proposed sample sites with locations historically used by the EA and NRW nevertheless proved fruitless, with too many sites not adhering to my pre-existing requirements. At least I did not commit too much time to this endeavour. Having navigated the issue of selecting what I considered to be appropriate sample sites, I was subsequently met with some challenges in the field.

Unbeknownst to me, and not evident when mapped, several of my sample sites were only accessible via private land, forcing several last-minute changes as I located alternative sites along my sample rivers – up to a few miles away – that could be reached on public land. Although I could have done without the stress of this, acutely aware of my daily workload required to remain on schedule and within budget, I will look back at this as an effective lesson in proper, prior, planning, with it prudent to have prepared a backup plan. This experience has helped me recognise that research projects can go awry in many unexpected ways and has made me more resilient in coping with and addressing such changes.

Phantom phosphate

I have thus far exclusively referred to my examination of water quality through the analysis of nitrate. This was not always the case; I had intended on sampling for both nitrate and **phosphate** concentrations, due to their strong association with sewage effluent and agricultural runoff into UK waterways (Meixian *et al.,* 2022; Rankl, 2023). While onsite, these measurements were to be completed as and when I had collected and prepared my river samples. However, after finishing sampling at my first location along the River Dart – a several-hour venture when including riverfly sampling – I realised this would prove too time-consuming, with approximately one week to complete my sampling from across the UK and remain within budget. Furthermore, the photometers' reagents used in my chemical analyses are designated as highly toxic to the environment with long-lasting effects. Besides the appropriate PPE to handle safely, this would have required a high level of care and precision I had not the time to afford. I resolved instead to

keep my samples chilled in a cool box, therefore, until the running of my tests was feasible. Although a bothersome setback, at the time I felt assured in this compromise.

As appears to be a recurring theme underscoring this project, upon later running the measurements of my samples for nitrate and phosphate, I was met with the final complication to shape my study's focus: phosphate was essentially absent from my samples. Since I had obtained a range of nitrate readings, I realised something was wrong. My prior understanding had been that nitrate and phosphate were considered stable in solution, with the samples kept cool to minimise microbial activity (Agency for Toxic Substances and Disease Registry, 2017; Comber *et al.,* 2015; Lloyd *et al.,* 2022). Further review of the literature led me to discover that, for phosphate analysis, this ought to be completed within 24 hours of sampling, after storage at 4°C in the dark (Lloyd *et al.,* 2022). This came as a great surprise, having believed I previously acted on reliable evidence. I also surmised that due to the specifications of the equipment I used, physicochemical parameters including iron and copper concentrations, and sample **turbidity**, may have unduly influenced my phosphate readings (Hanna Instruments, 2025).

Regardless of the cause, I was left with little choice but to discard phosphate from my write-up. Although unlikely to have ultimately altered my conclusions, this will teach me the danger of assuming the reliability of a couple of corroborated sources, while learning the importance of thorough literature reviews to ensure no contradictions arise to later undermine any aspect of my research.

Conclusion

Returning to the concept of 'shifting priorities' that has come to define my study, I believe that, despite my struggles, this will ultimately benefit me in all aspects of independent research. From appreciating the constraints of budgeting and time on analytical power, to the recognition of realistic aims, supported by contingency planning in case of malign circumstances, and

ensuring this is corroborated by the academic literature, I feel I have grown more resilient to the volatility that can come with executing research. The sense of uncertainty and foreboding, however, that comes with recognising and attempting to respond to failure is often worse than the actual issue at hand, as evidenced by the academic poster that I produced from my study and later presented at both the British and International Conferences of Undergraduate Research. To summarise, while this was a decidedly enjoyable, fulfilling experience, and one which ought to benefit my undertaking of future projects, I realise now how executing independent research is rarely without its difficulties. Since beginning a new study in the summer of 2025, I feel I have, so far, improved my adaptability to problematic circumstances, avoiding the pitfalls of past errors and oversights. I am currently writing up this project and am applying to present at an academic conference later this year.

Acknowledgements

I would like to acknowledge and thank my supervisor, Robert Lillywhite, for all his support with this project. The countless Teams meetings, providing invaluable advice – without limiting my freedom to figure out issues independently – and unyielding patience in helping keep me grounded in what was feasible with my budget and time constraints. Without Rob, my project would never have turned out the way that it did, nor open so many doors for me going forwards.

Appendix

Website: https://www.uk-river-report.org.uk/

Poster:

Testing the limits. Can nitrate levels be used to safeguard the health of UK rivers?

Federico Fidel White

Aim of study:

To investigate the influence of nitrates on the health of UK rivers. This will consider the relative importance of the different sources and the consequences of nitrate pollution, and the need to impose limits to safeguard water quality and environmental health.

Introduction:

- As of 2024, only 14% of English rivers achieved good ecological health.

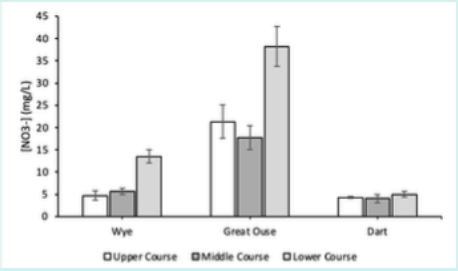
- The top three sources preventing waterbodies achieving good ecological status are: agricultural pollution (40%), sewage and wastewater (36%) and urban diffuse pollution (18%).

Materials and methods:

- Nitrate testing: conducted using a Hanna HI-97728 Nitrate Photometer to obtain an average for the upper, middle and lower courses of each sample river.

- Invertebrate sampling: Environment Agency standard three-minute kick sample and one-minute manual search along each sample river, as for the testing of nitrate concentrations.

Results: nitrate concentration and river fly abundance



Nitrate concentrations along the lower course of the Wye were significantly higher compared to the upper and middle courses; the same was true for the Great Ouse. However, no significant difference was recorded along the Dart.

Nitrate levels across the three rivers were significantly different, with the Great Ouse being the highest.

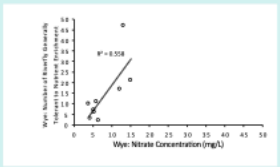
Course Comparison	River Wye (x̄)	River Great Ouse (x̄)	River Dart (x̄)
Upper vs Middle	NS (4.70/5.70)	NS (21.3/17.7)	NS (4.30/4.03)
Upper vs Lower	*** (4.70/13.5)	*** (21.3/38.2)	NS (4.30/4.97)
Middle vs Lower	*** (5.70/13.5)	*** (17.7/38.2)	NS (4.03/4.97)

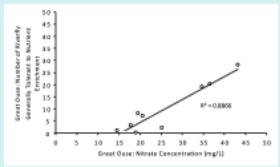
Correlation between nitrate concentration and riverfly abundance:

Riverfly Tolerance	Wye: [Nitrate] (Pearson C.C)	Great Ouse: [Nitrate] (Pearson C.C)	Dart: [Nitrate] (Pearson C.C)
Generally Tolerant	*** (0.747)	*** (0.942)	NS (-0.457)
Intermediate Tolerance	NS (-0.181)	*** (-0.854)	NS (0.277)
Generally Intolerant	*** (-0.831)	NS (-0.542)	NS (0.572)

x̄ = mean (mg/L), NS = not significant, * = significant (p ≤ 0.05)**

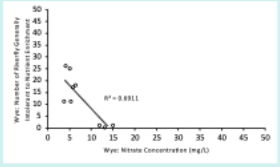
Nitrate concentrations on the lower Wye were greater than 12.1 mg/L which favoured tolerant riverfly.

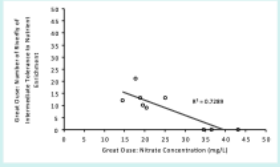




Nitrate levels along the lower Great Ouse were higher than 34.7 mg/L, favouring tolerant riverfly.

Oppositely, intolerant species, were only abundant upstream, between 3.9 - 6.5 mg/L.





However, intermediate tolerance riverfly were only recorded further upstream, at a range of 14.6 - 25.2 mg/L.

Conclusions:

- There are several chemical parameters used in the determination of water quality. This study has focused on nitrate as a proxy. Riverfly abundance is a useful indicator and can be used to demonstrate how environmental health varies across the length of a river and between rivers.

- The results suggest that higher nitrate concentrations favour tolerant species, over intermediate and intolerant riverfly.

- By mapping the major sources of pollution affecting each sample river (QR code below), this further highlights the need to limit nitrate levels. However, this also presents an interesting consideration of whether addressing these inputs directly or focusing on implementing legislation to tackle the consequences of these activities, is of greater importance.

- The changes in riverfly diversity may be in part attributed to the sharing of ecological niches, on top of tolerance to nutrient enrichment, as with rising nitrate concentrations, intolerant species are unable to as readily compete with more tolerant riverfly.

- The results for the Wye and Great Ouse suggests that limits for nitrate concentrations could benefit overall species abundance and should be introduced for UK rivers, as there already exists for reactive phosphorus. However, with contrasting thresholds across these rivers, any legislation should go beyond generalised standards and be tailored specifically to each UK river, using a holistic assessment approach.

Important links:

References

Sampling map

Website/blog

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Glossary

Anthropogenic pressures: Refers to the various human-induced factors that create environmental stress, significantly impacting ecosystems and biodiversity.

Health: The characterisation of an ecosystem's condition and functionality derived from a range of physicochemical and ecological parameters.

Intensive farming units: Farms that practice the high density rearing of livestock, often associated with issues around animal welfare, and which produce large quantities and concentrations of animal waste. If improperly recycled, the latter, rich in nitrate and phosphate, risks contamination of waterways and groundwater from resulting runoff.

Nitrate: A compound of nitrogen and oxygen, found naturally at low levels in freshwater environments. Also, a component of fertilisers and raw sewage effluence – occurrence at higher concentrations is indicative of agricultural runoff or sewage discharge, causing eutrophication. Concentration measurements were conducted in the study using a Hanna HI-97728 Nitrate Photometer.

Physicochemical: Relating to the combined physical and chemical parameters that define and influence environmental conditions, such as the concentration of pollutants in a river, and the river's turbidity.

Phosphate: A compound of phosphorous and oxygen, found naturally at low levels in freshwater environments. A component of fertilisers and sewage effluence, phosphate runoff similarly causes eutrophication. Concentration measurements were conducted in the study using a Hanna HI-713 Phosphate Checker.

Photometer: An instrument used to measure the concentration of chemical substances, such as nitrate and phosphate, in a solution. This relies on measuring the transmission or absorption of light at a certain wavelength,

often using a reagent to react with the substance of interest, colouring the solution proportionally to its concentration. In this instance, the reagents used for the nitrate photometer and phosphate photometer are both toxic and harmful to the environment.

Riverfly: A family of invertebrates, most of whose life cycle is spent in freshwater ecosystems such as lakes and rivers. Consisting of 33 invertebrate groups, these are used as a standardised monitoring technique, often in conjunction with several physicochemical parameters, to determine the health of rivers and other freshwater systems.

Turbidity: A key test of water quality concerning the cloudiness, or opacity, of a water sample. Caused by the presence of suspended particles such as algae and silt, this can negatively influence pollutant readings due to the scattering and absorbance of light otherwise detected by measuring equipment.

Urban diffuse pollution: Environmental contamination originating from dispersed, non-point sources within the urban landscape, such as from street runoff and poorly managed storm overflow systems.

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Mysteries for Humans: Navigating the Maze of Science, Objectivity and our Mental Limits

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Abstract

My project explored the idea that science, often upheld as the epitome of objectivity, may instead resemble a maze of our own creation. Drawing inspiration from Penelope Scott's 'Mysteries for Rats' and Chomsky's concept of 'mysteries-for-humans', the work considers how social structures, institutions and scientific practices can form problems we are unable to conclusively solve. The exhibit's structure deliberately avoids resolution, echoing both intellectual dead ends encountered during philosophical discussion and the recursive loops of institutionalised science. Ultimately the goal is not to provide answers but to provoke curiosity, encourage openness and prompt reflection on the limitations of human knowledge. Engaging openly with other disciplines may allow us to examine a question more fully and utilise these unique perspectives to form creative solutions.

Mysteries for Humans

> A scientist stands watching the ants, taking careful notes to bring back to his supervisor so that we humans can make efficient technology that creatively solves problems. And when the scientist gets back to his supervisor, at a university or a company or a government agency, his research may be implemented in any number of technologies that are hostile to human life, that diminish our enjoyment or limit our creativity, that scorch the earth we live on. We find clever solutions, and we take careful notes, and our needs are rarely met.'Why didn't you change the structure?' says an ant to a scientist, 'Didn't you want your needs to be met? Didn't you want your community to thrive?''I thought I was doing what I was supposed to do,' says the scientist, 'I thought I was being good. I don't know what I did wrong.'He wants to be good, he tries to be good, and he cannot solve the maze.

(Scott, 2024a)

The inception of what would later evolve into my student-devised assessment (SDA) was an album and accompanying online essay describing the recurring themes within it. Penelope Scott's 'Mysteries for Rats' is, at its core, an exploration of the mental limits of human beings. These ideas are heavily based upon Chomsky's theory that human intelligence must have boundaries, and thus there will be some questions to which the answers lie beyond our scope. 'Just as rats are unable to run mazes with numerical properties, lacking the appropriate concepts. Such questions we might call "mysteries-for-humans", just as some questions pose mysteries-for-rats' (Chomsky, 1995). Using this as a springboard, Scott suggests that it may be possible for humans to have created so-called mazes through the formation of societies and structures that we are incapable of solving.

This idea resonated deeply with me and was pulled back to the forefront of my mind during my Rethinking Health Science module. Discussions prompt new connections, threads of thoughts that you want to pull on but can never find the end of. It is as though you can never see the whole picture at once, and perhaps if you could, it would all become clear. You cannot solve, or even attempt to map out, the maze.

Preconceptions are challenged and ripped down, but you are not handed a neat and robust alternative. This leaves a void where a confidently held belief once stood. If one is willing to engage deeply, I believe this void is not plugged with a new prevailing opinion (as Kuhn's concept of **paradigms** would suggest (Kuhn, 1970), but instead a sense of curiosity and openness. An understanding that you must leave space for the contradictory, the unexplainable and the nuanced. This is the experience I hoped to create with my SDA.

The SDA was intended to serve as an interactive exhibit for a hands-on scientific museum. The exhibition functions as a maze, inviting users to explore logical fallacies and common misconceptions, leading them through a narrative that attempts to answer the question 'Is science objective?' The

maze guides users down a number of avenues, covering statistical sleights-of-hand, moral dilemmas and conflicting perspectives. This exploration ends without a final solution to the initial question, instead offering the response 'Big problems like objectivity rarely have neat, easy solutions. Accepting and welcoming the "problem" is sometimes the only way out.' The ceiling of the maze opens, allowing the user to escape and view the entire structure from above. From here it is clear that there was never an exit; the structure is entirely unintelligible.

> The more they walk, the more pheromones they leave, which causes more ants to follow the path, which leaves more pheromones, and your ears are ringing and the sound is getting louder and we all know how that feels. Sometimes these Ant Mills dissipate, but sometimes they do not, and the ants begin to die of exhaustion.'Why didn't you break the loop?' says a rat to an ant, 'Didn't you want to live? Don't you want what's best for the hive?''What is a loop?' says the ant, 'Of course I wanted what was best. I don't know what I did wrong.'They want to live, they try to live, and they cannot solve the maze.

(Scott, 2024b)

The idea that science is strictly objective and the question of how we maintain this standard may be considered one of these 'mysteries-for-humans'. Science as an institution is shaped by hundreds of thousands of human beings across time and space, and in turn it shapes us back. What it means to be a scientist is drilled into us in education, in industry, by peers, colleagues, lectures and books. In this capacity, we might imagine science to be somewhat like the **ant mill** that Scott describes in her essay. We are stuck in a **feedback loop** where individuals shape institutions and institutions shape individuals.

Concepts become embedded in scientific practice, such as our increasing reliance on **p-values** as an absolute criterion for success, which is far from what Fisher was recommending when he first popularised it in 1925 (Kyriacou, 2016). Over time this statistical measure has solidified into the shining beacon of objective experimental design, despite its many shortcomings and vulnerabilities. What was once a flexible guideline has become a self-perpetuating norm, demanded by journals and disseminated by schools. An over-reliance on conventional procedures like p-values do not benefit the

scientific community but has been so entrenched by society that we cannot imagine another way. Perhaps what it takes to break out of this loop is to keep our minds open and communicate freely with those outside our discipline. Interdisciplinarity allows us to see our blind spots, share our strengths and conceptualise the maze in ways we previously could not.

> Turn to the rat next to you and start a conversation. […] By acting as a network instead of a single unit, you may begin to 'see' the structure of the Mystery.

(Scott, 2024b)

While Haraway argued that science should embrace our own limited positions – our 'situated knowledge' (Haraway, 1988*)* – perhaps when we work together, we are able to combine these unique 'situations' and build up a patchwork that will eventually show us the whole picture. If we are willing to engage openly with each other, perhaps we can escape the maze together. I believe that is the true value in interdisciplinarity.

The greatest challenge I faced in creating this project was reconciling the 'profound' piece of art I aspired to make, with the understanding practically the need for it to remain palatable and accessible to a general audience. Walking this line meant paring back many of the more philosophical and abstract elements, and ultimately this compromise was not entirely successful. As a result, the piece seems to be left torn between two audiences: too complex and obscure for the average museum-goer, yet too surface-level for those more familiar with the subject. However, the content itself was not the sole focus of the exhibit. If even one person were to play it and experience a lapse of confidence, a feeling of disorientation or question any aspect of their worldview, I would consider it a success. Above all else, the maze says, 'Sometimes we must live with ambiguity; we don't always get the answers.'

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Glossary

(Scientific) paradigm: A set of concepts or thought patterns that serve as a framework for observing, understanding and interpreting (scientific) phenomena.

Ant mill: A phenomenon where ants follow each other's chemical trails and get stuck in a continuous loop.

Feedback loop: A cycle where the output of a system influences the input, reinforcing the same pattern.

P-value: A statistical measure used to decide whether results are significant or not, based on a benchmark value (typically 0.05).

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Artificial Intelligence and Children's Learning: Exploring the Potential to Support

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Abstract

This paper explores the evolving role of Artificial Intelligence (AI) in primary education, highlighting its potential to personalise learning, alleviate teacher workload and enhance student outcomes. It critically examines the integration of AI technologies, ranging from intelligent tutoring systems to voice-activated assistants, and their implications for **pedagogy**, student wellbeing and digital literacy. While acknowledging AI's transformative capabilities, the paper similarly addresses ethical concerns, including data privacy, bias and overreliance on automated systems. Drawing on current research, educational policy and practical examples, it advocates for the responsible adoption of AI guided by informed teacher judgement and robust digital literacy education. Ultimately, it calls for collaborative efforts among educators, technologists and policymakers to ensure AI enriches learning without compromising human values or professional integrity.

Keywords: Artificial Intelligence (AI) in primary education, AI and personalised learning, Digital literacy in children's learning

Technology is increasingly becoming a necessity in our world as we adapt ourselves to adopt its nature (Worth, 2024). This codependency is evident among young learners who seamlessly navigate their lives both online and offline (Department for Education (DfE), 2023), generating a staggering average screen time of six hours per day for children in Key Stage 2 (Binns, 2024). As one of the most promising forms of technology today, **Artificial Intelligence (AI)** has created exciting possibilities within the education system as it strives to remain relevant (Major *et al*., 2018). Referring to various computer systems designed to emulate intelligent human behaviours such as reasoning and learning (Chen *et al*., 2020; Liang *et al*.,

2021), AI offers remarkable potential to support children's learning. In response to the COVID-19 pandemic, AI is progressively becoming integrated within education policy and practice (Chen *et al*., 2020), influencing classroom discourse (Tuomi, 2018). Seen as a transformative tool for crafting **personalised learning** experiences (Carroll and Borycz, 2024), AI is thought to revolutionise education (Patrick and Javed, 2024). However, others contend that its rise leads us towards a fully automated future based on a system that knows everything but understands nothing (Atherton, 2018). While AI is unlikely to replace teachers, it is crucial for educators to grasp both its potential and challenges (Worth, 2024) in light of its integration into the learning environment (Patrick and Javed, 2024).

For the potential of AI to be fully realised, its development and application must be conducted in a secure and responsible manner. Consequently, its use in schools requires careful consideration, not only to understand its potential in supporting children's learning (Schroeder *et al.,* 2022) but also to question the risks and uncertainties it introduces. From my experience as a student teacher, observations indicate that AI is being integrated with varying degrees of confidence and purpose, ranging from teachers experimenting with classroom tools to pupils engaging with automated systems almost instinctively. These encounters reveal a tension; AI is simultaneously fluid and unfamiliar, widely present yet frequently misunderstood. Across these contexts, two dominant positions emerge: educators who are hesitant to approach AI, often stemming from limited awareness of its possibilities, and those who embrace its integration with little restraint, at times to the potential detriment of their students' wider needs. Despite these differences, both positions underscore a shared requirement, a comprehensive understanding of AI's capacities, coupled with the critical scepticism required to maintain robust pedagogical practice. In response to this ongoing debate, strategies to support pedagogies that thoughtfully integrate AI will be examined, with implications for future educational practice.

Contrary to belief, utilising AI to enhance conventional routines is not a new concept (DfE, 2023), having held a role in supporting children's

learning for more than a decade (Luckin, 2023). However, with advancements in technology, its usage has become second nature, making the need to embrace such technologies in education evermore significant (Mitra, 2012). Paving a way to the future of education is a private school in London, which places AI at the forefront of their children's education as opposed to human teachers. This decision for a teacherless class was made in reaction to the meticulous nature of AI, and utilises its ability to learn from students and tailor teaching to individual strengths and areas of development (David Game College, 2024). Although current success has been proclaimed in supporting children academically (Carroll, 2024), it could be viewed that a change this drastic does not fulfil the wider needs of all learners and undermines the role of the teacher (Butler and Starkey, 2024). Furthermore, given the pandemic's negative impact on children's mental health due to isolated online lessons (Worth, 2021), the question arises of whether educators have genuinely learnt from past mistakes. Although the teacherless class is set in a secondary setting, the need for schools to focus on children's wellbeing is essential (*YoungMinds*, 2020); entrusting computers with full responsibility is not currently the solution (Nguwi, 2023). As witnessed during the pandemic, the absence of meaningful human connection left many learners struggling socially and emotionally, emphasising that technology alone cannot meet the holistic needs of children.

Mental health affects cognitive learning and development, highlighting the need to evaluate AI's role in balancing wellbeing with academic achievement (Public Health England, 2021). Mitra (2017) acknowledges that with recent technologies, teachers need not play as central a role for educational progression. Instead, the success of learning hinges on collaboration among students while allowing them to work alongside technologies to discover knowledge. By creating a more fluid learning environment, AI challenges traditional educational structures that emphasise teacher-led instruction. AI tools can foster **cognitive development** in ways that Piaget's (1926) model overlooks, challenging the idea of fixed stages by encouraging a more adaptable understanding of cognitive growth. However, parallels can still be drawn between traditional

and AI-enhanced learning by promoting exploration as an active experience (Fiorella and Mayer, 2016). While not every lesson should be entirely student-driven (Mitra, 2017) – especially given the limited research on the long-term effects of these methods (Wilby, 2016) – evolving educational practices can create significant opportunities for development. Fundamental to this process is the empowerment of students, which AI enhances by providing access to technology, enabling exploration of own knowledge, and developing individual thought as opposed to rote learning, ultimately cultivating **self-regulated learners** (Luckin, 2023).

AI can significantly enhance classroom discourse and the learning experience in primary schools when implemented thoughtfully (Tuomi, 2018). One innovative approach involves AI-driven robots, which demonstrate how to create self-regulated learners without marginalising the role of the teacher (Jones and Castellano, 2018). In Sweden, specialist robots have already been used in various social roles within classrooms, including answering questions appropriately to maintain pupil confidence, such as in the **EMOTE project** (Serholt and Barendregt, 2016). While such advancements appear revolutionary, they come at a cost, having limited functionality prone to breakdowns due to insufficient development, explaining why not many social robots are used regularly in education (Selwyn, 2019). For many teachers, identifying the failings of robot use in education is a relief, finding it hard to overcome the clichés and fear-inducing stereotypes often perpetuated by the media (Atherton, 2018). However, interactions within digitally enhanced classrooms are evolving, with technologies increasingly becoming integral to teaching and learning (Selwyn, 2019). A more accessible form of robotics widely accepted and utilised includes **voice-activated assistants**, intelligent personal assistant devices, such as Amazon Echo and Google Home. If these **generative AI** devices are specifically designed with educational functions, they have the potential to serve as intelligent learning assistants that can significantly influence future classroom practices (Butler and Starkey, 2024). It is important to emphasise that this development should not diminish the role of teaching assistants, who carry out a variety of essential tasks

beyond the capabilities of voice-activated devices – something that has been directly observed. However, the demands of this role can be high, particularly when students hesitate to progress until their specific needs are met. In this context, AI devices could help alleviate some pressures and enhance classroom discourse. Observations in practice demonstrate that when these devices are used with care and oversight, they can ease classroom management, although never fully replicate the nuance of human interaction.

To ensure suitability for primary classrooms, adapted algorithms must prevent inappropriate responses when students seek personal advice or reassurance, as children tend to anthropomorphise artificial entities to enhance their understanding of an unpredictable world (Epley *et al.*, 2007). Thus, the ethical implications of designing educational technologies that invite **anthropomorphism** warrant careful consideration, alongside a critique of algorithms (Perrotta and Selwyn, 2020) and cultural biases, particularly when such technology is not expressly developed for educational purposes (Celik, 2023). Although these advancements are currently in development (Atherton, 2018), presenting AI as an educational tool should complement, rather than replace, human intelligence (Luckin, 2016). This approach enhances the learning experience, fostering greater interactivity and dynamism that promotes a culture of enquiry and empowers students to explore (Luckin *et al*., 2016). Consequently, before realising these benefits, it is essential to address misconceptions about robots among educators in order to fully harness AI's potential to transform classroom discourse and create an enriching learning environment (Wang *et al*., 2024). Recent government guidance echoes this, underlining the importance of safe, transparent and human-centred integration of AI in schools (DfE, 2025).

To experience the transformative potential of AI in education, it is essential to embrace personalised learning approaches that cater to each student's unique needs and preferences (Muthmainnah *et al*., 2022). By utilising data analytics and **adaptive technologies**, teachers can provide tailored learning experiences through AI that engage students through

their interests and support individual growth trajectories (Pallai, 2023). This personalisation not only addresses varying learning styles (Hood, 2024) but also helps to identify and rectify misconceptions, enhancing student outcomes (Luckin *et al*., 2016). In school experience, examples of these tools have been embedded within classroom routine – with one of the most successful being **Times Tables Rock Stars**. This is a prime example of where AI can take an area of the curriculum with low retention and transform it into an enjoyable experience, motivated by friendly competition that enhances engagement and understanding (Patrick and Javed, 2024). AI's ability to improve confidence and fluency can similarly benefit children with Special Educational Needs, including those with dyslexia (Reid, 2017). For instance, AI-driven applications such as Nessy offer personalised reading support, enabling students to develop their skills at their own pace, thereby fostering greater independence, social inclusion and overall learning capabilities (Giaconi and Capellini, 2020). While these applications encompass activities that a proficient educator might design (Luckin *et al*., 2016), the increasing time constraints faced by schools necessitate the use of AI to offer immediate feedback and tailored practice (Roberts, 2024). This real-time assessment allows students to appreciate progress and areas for improvement, ensuring that all learners feel empowered to engage fully in their educational journeys (DfE, 2024). However, while these innovations hold promise, disparities in access to AI technologies can exacerbate existing educational inequities, particularly in disadvantaged areas (Sperling *et al*., 2022). Furthermore, the effectiveness of these AI systems relies on fostering a culture of resilience and adaptability in students (Schroeder *et al*., 2022). Without a supportive learning environment, even advanced technologies may fail to realise their full potential (Dweck, 2012). Moreover, if children are consistently exposed to information delivered by a computer, their ability to critically assess and analyse the validity of what they are transmitted may be compromised (Dans, 2023).

Engaging in children's **digital literacy** is essential when navigating the online world (DfE, 2023). With advancements in **computer augmentation** and fake news, identifying what is real and fake is increasingly becoming

an issue – evidenced by the staggering statistic that one in five children believes everything they read online as true (National Literary Trust, 2018). Highlighting children's inability to critically evaluate online information creates concern in a world evermore dependent on the internet as an information source (Leu, 2017). The technology's capacity to generate misleading or false information can be exemplified by **AI hallucination**, where AI systems produce responses that are not grounded in reality (Burrett, 2024). The possibility of bias in AI-generated content and the circulation of misinformation present concerns for perpetuating stereotypes and undermining inclusive learning environments, posing significant ethical issues (Ardoin and Hicks, 2024). Therefore, it is important for teachers and children to be aware of the potential for bias in AI-generated content (DfE, 2023).

To contest this, it is commonly agreed that assessing the validity of knowledge requires children to develop a degree of healthy scepticism (Burrett, 2024; Dalton, 2015; Leu, 2017; Ofcom, 2022; Pilgrim *et al*., 2019). Developing reliable reasoning to determine truths on websites can be routed in credibility of the author, examining links and assessing the domain used (Pilgrim *et al*., 2019). Continuing to develop this critical thinking, determining AI hallucination can be trickier due to its enthusiastic and convincing responses (Ardoin and Hicks, 2024). However, if children know that AI is not always truthful, they are more likely to treat information with caution (DfE, 2023). To encourage this scepticism, Burrett (2024) suggests having children ask AI questions that are known lies, to which AI would produce a natural-sounding, but fabricated, response (Figure 1). Conversely, with some platforms, such as ChatGPT, significant advancements have been made, which can provide accurate information when asked the same question (Figure 2). Although accuracy could differ with other questions, it highlights the speed at which AI is developing, making distinguishing fact from fiction challenging. Therefore, for digital literacy to be developed, children should be exposed to big ideas both on and offline. Using philosophy for children assists with e-safety while encouraging critical thinking and exploring issues from multiple perspectives, minimising bias (Goto, 2022). By empowering

children to engage thoughtfully with AI, teachers can foster a generation of learners who are sceptical in using technology but equipped to navigate the complexities of the future world they are helping to shape (D'Olimpio, 2017).

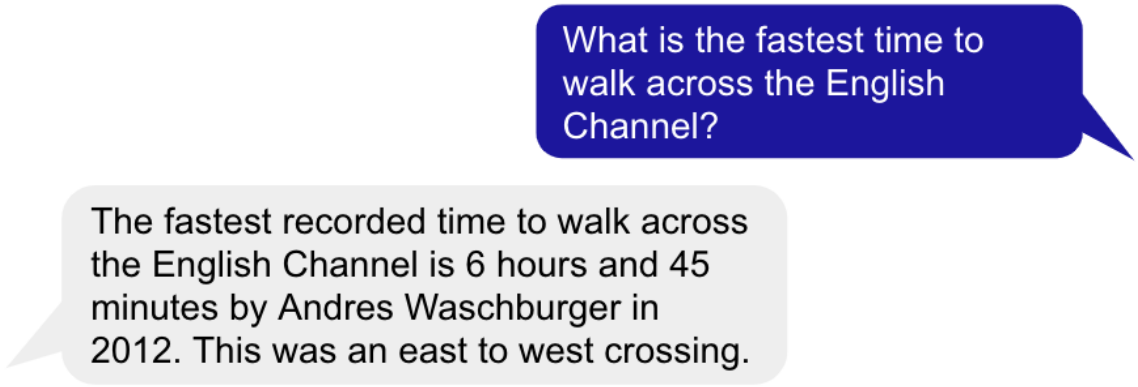

Figure 1: Answer generated from Microsoft Co-pilot in Bing

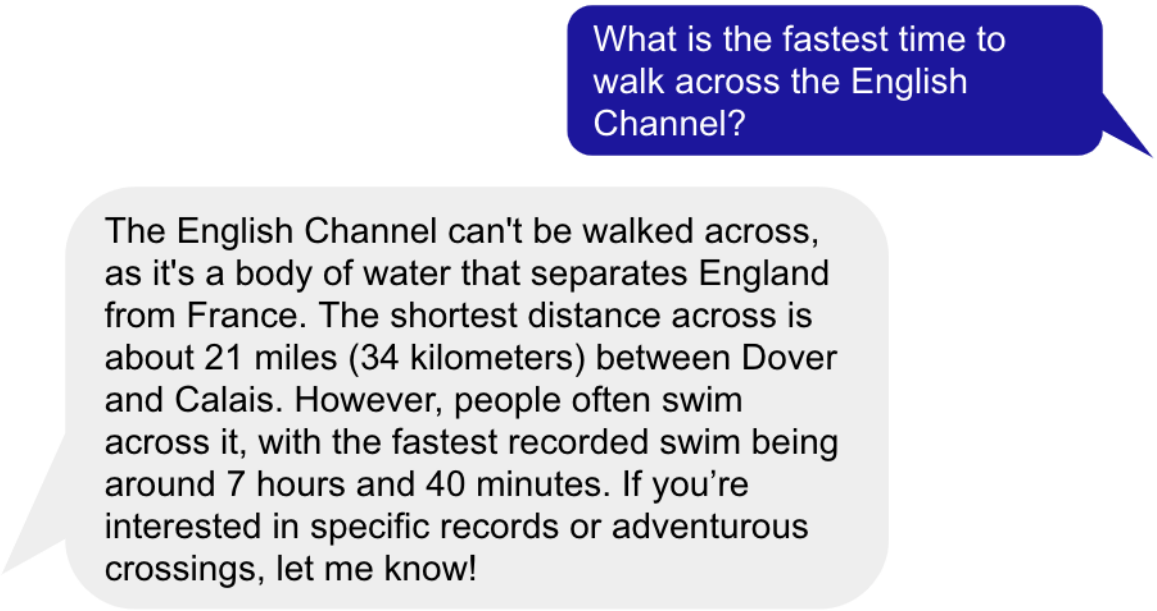

Figure 2: Answer generated from ChatGPT 4o

While it is crucial to equip children with the skills to navigate the complexities of the online world, it is equally important for teachers to recognise and embrace the benefits that AI offers themselves (D'Olimpio, 2017). Reports indicate that teachers are suffering from high demands, poor work-life balance and perceived lack of resources (Ofsted, 2019), with

only 1 per cent feeling their workload is manageable (National Education Union, 2024). Contributing to current recruitment and retention challenges, generative AI could serve as a transformative tool to lighten administrative burdens, aiming to improve teacher morale and job satisfaction (Schroeder *et al*., 2022). However, a recent example showed that some teachers, despite recognising the benefits of AI, misuse it because they lack the training needed to use it effectively (Worth, 2024). Much about successful usage lies in the ability to write effective prompts to enable the domain to provide the most relevant results (Burrett, 2024). Such prompts should not include identifiable data, as anything inputted into AI gets permanently stored; these could include personal data and pupils' work without consent, which could unethically train generative AI models (DfE, 2023). Furthermore, any responses gathered must be sense-checked against a schema, reducing the possibility of overreliance causing plagiarised outcomes (Pilgrim *et al*., 2019). By using AI to reduce time spent on non-pupil-facing activities, teachers can dedicate more attention to students requiring targeted support (Schroeder *et al*., 2022), enhancing their ability to deliver high-quality education (DfE, 2023). By balancing the advantages of AI with caution in its usage, educators can create an environment where technology serves as a powerful ally in supporting children's learning (DfE, 2024). This thoughtful integration of AI enhances teacher effectiveness, leading to more meaningful learning experiences for students (Atherton, 2018).

In our current climate, where enhancing children's learning experiences is paramount, integrating AI into education presents a compelling opportunity (Patrick and Javed, 2024). By alleviating teacher workloads and enabling personalised instruction, AI can create engaging and adaptive learning environments tailored to diverse student needs (Sperling *et al*., 2022). However, despite numerous studies advocating for AI's inclusion in the classroom, only a small proportion of teachers have been observed practically applying and evaluating these technologies. This raises concerns that the speculative future of AI might overshadow our understanding of its real impact on students (Sperling *et al*., 2022). Nonetheless, given the Department for Education's (2023) endorsement,

ongoing global teacher shortages and drive for more efficient practices, the role of AI in teaching remains uncertain. However, it is important to emphasise that utilising AI is not about replacing teachers, but enhancing their capacity to meet varied learning requirements. As future educators, it is vital to recognise both the potential and pitfalls of generative AI, remaining mindful of the challenges it brings, such as data privacy and the necessity for adequate teacher training (Worth, 2024). As advancements in algorithms continue, it is essential to understand that the support AI provides for children's learning should be guided by teachers' professional judgement and knowledge of their students (DfE, 2023). Ultimately, this research has highlighted an urgent need for collaboration among educators, policymakers and technologists to harness the transformative power of AI, ensuring it enriches the educational landscape and prepares students for a dynamic future. In the meantime, however, it emphasises the teacher's role to continue engaging with and exploring the multifaceted elements of AI education, approaching its integration with informed curiosity and a commitment to student welfare (Sperling *et al.,* 2022).

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Glossary

Adaptive technologies: Tools or systems that modify content or instruction in real time based on learner performance or needs.

Anthropomorphism: The attribution of human traits, emotions or intentions to non-human entities, such as robots or AI systems, especially by children.

Artificial Intelligence (AI): The simulation of human intelligence processes by machines, particularly computer systems, which includes learning (machine learning), reasoning, problem-solving and language processing.

Cognitive development: The process by which individuals acquire and develop intellectual abilities such as thinking, reasoning, problem-solving and understanding.

Computer augmentation: The enhancement of human capabilities through digital tools or technologies, often used in educational or professional contexts.

Digital literacy: The ability to effectively and critically navigate, evaluate and create information using a range of digital technologies.

EMOTE project: A three-year initiative to develop empathic artificial tutors for real classrooms. These tutors supported teachers through pedagogical games on map-reading and sustainable development, adapting to students and linking activities to curriculum goals.

Generative AI: A subset of Artificial Intelligence that can create new content, such as text, images or code, based on patterns learnt from data. Examples include tools like ChatGPT or Microsoft Co-Pilot.

AI hallucination: When an AI system produces plausible-sounding, but false or misleading information not grounded in real data or facts.

Pedagogy: The method and practice of teaching, especially as an academic subject or theoretical concept.

Personalised learning: An educational approach that tailors instruction, content, and pacing to the individual learner's needs, preferences and interests, often supported by technology.

Self-regulated learners: Students who are able to manage their own learning through goal-setting, self-monitoring and self-reflection, often facilitated by feedback or scaffolding.

Times Tables Rock Stars: an online program that helps primary school children practice multiplication through timed games and rewards.

Voice-activated assistants: AI-powered devices that respond to spoken

commands and can perform tasks or answer questions, for example Amazon Echo or Google Home.

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IATL at 15: Educational Innovation Then, Now and in the Future

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Abstract

The paper traces the evolution of the Institute for Advanced Teaching and Learning (IATL) at the University of Warwick as it marks its 15th anniversary. Since its formation in 2010, IATL has served as a catalyst for educational innovation, championing interdisciplinary learning, undergraduate research and student–staff co-creation. The authors reflect on IATL's foundations in Open-Space Learning (OSL) and Student-as-Producer, its development as an academic department and its influence on sector-wide conversations about agential learning and innovative assessment. They conclude with a discussion of possible directions of travel for educational innovation in the next decade, including the challenges and opportunities of artificial intelligence.

'What's past is prologue': 2010–2013

IATL was established in 2010 when the CAPITAL and Reinvention Centres united to form a new academic department at Warwick (Bate and Brock, 2007; Monk *et al*., 2011; Neary, 2020). Since then, IATL has become an institutional leader in educational innovation, undergraduate research and co-creation with students. This section will provide a short overview about the foundation of IATL and its initial years of operation. During this time, IATL further developed the *Reinvention* journal, hosted the British Conference of Undergraduate Research (BCUR) in 2012 and founded the International Conference for Undergraduate Research (ICUR) in 2013. IATL continued to innovate and disseminate experimental teaching methods through the Open-Space Learning (OSL) project:

> OSL developed from the work of Warwick's CAPITAL Centre (Creativity and Performance in Teaching and Learning), which was one of HEFCE's Centres of Excellence in Teaching and Learning (2005–10). CAPITAL was a collaboration between [Warwick] and the Royal Shakespeare Company. The basic idea was to apply the practices and theories of the theatrical rehearsal room and the theatrical ensemble across a university curriculum. From these early aspirations developed a pedagogy that [was embedded across departments] including Chemistry, Law, Business, English, Mathematics, Philosophy, and Medicine.('Teaching Excellence' website, 2013)

Working collaboratively between 2010 and 2013, the first IATL team combined the OSL approach to learning with the 'Student-as-Researcher' philosophy to create an experimental portfolio of modules that would be open to students from any department or course of study at the University of Warwick. The final piece of the jigsaw was laid down when the University formally established IATL as an academic department, with its own academic staff, in 2013. This enabled the IATL team to start planning in five-year cycles, in consultation with key stakeholders such as the Provost and PVC Education.

'Becoming IATL': 2014–2023

Building upon these solid foundations, the newly established academic department set about embedding itself within the various faculties and services of the University. It engaged with the Academic Development Centre (then the Learning Development Centre), the Library and Teaching Quality (now Education, Policy & Quality) to develop innovative practice that would address key priorities in academic pedagogy, student engagement and teaching excellence (e.g. interdisciplinarity, internationalisation and student research). During this period, IATL funded Strategic Projects, Academic Fellowships and Pedagogical Innovations that brought staff and students together to collaborate and disseminate their findings. Additionally, the Monash–Warwick Alliance awarded IATL funding to expand ICUR into new areas of research by growing the international partners to establish a truly global network, which was supported by the re-launch of the *Reinvention* journal as a global platform.

As part of IATL's ongoing work with student leaders – as *Reinvention* editors and ICUR directors, as well as the Student Ensemble (which had emerged from

the OSL project) – the IATL team were increasingly in demand as academic advisers or educational consultants to external departments and universities. Adapting the 'Student-as-Producer' model (Neary, 2020), IATL continued to commission, fund and showcase student-led practice, including creative learning, student enterprise and interdisciplinary research. The Student Ensemble grew into an international network of graduate theatre companies and alumni artists, which was routinely showcased at the Emerge Festival at Warwick Arts Centre (2014 onwards), leading to a nomination for 'School of the Year' at The Stage Awards 2016.

The international partnership with Monash was greatly enhanced in 2015 by the foundation of two educational academies: the Warwick International Higher Education Academy (WIHEA) and the Monash Education Academic (MEA), which supported and disseminated pedagogical scholarship that showcased the work of IATL within the wider academic community. In particular, the Monash–Warwick Alliance enabled collaborative practice with new technology to enhance our teaching, learning and research with students (via funded projects and collaborative modules). Building upon the existing collaborations with Academic Technology, Audio-Visual Services and IATL, team members were actively co-constructing spaces for technology-enhanced learning (see Monk *et al*., 2015) and global research events (see Barker and Gibson, 2022).

Working in collaboration with Monash, EUTOPIA and other international partners, IATL Teaching Fellows have developed both subject-specific and transdisciplinary practices that have complemented the student research portfolio and the research-based teaching agenda. Such was the collective and multi-professional character of these projects, there is insufficient time and space to name all collaborators, contributors and convenors here. However, it should be noted that IATL emerged as a professional environment that attempted to collapse the traditional distinctions that are often made between 'academic' and 'administrative' forms of labour (see IATL, 2024) and indeed the hard distinctions between 'staff' and 'students' (in the case of co-creation practice, which has since been replicated externally, by the 2022 Inclusive

Education Project with University College Birmingham, and internally, via the 2023 Institutional Teaching and Learning Review). Generations of students and staff alike have participated alongside each other as researchers, educators and leaders to enable the growing reputation of IATL within the sector as the 'hub' for educational innovation. Even during the pandemic, IATL continued to innovate and expand its horizons, hosting the 5th Interdisciplinary Learning and Teaching Conference (2021) and the World Congress on Undergraduate Research alongside the British Conference of Undergraduate Research (both 2023).

'A year in review': 2024–2025

From 2024/25, IATL continued to pioneer in the design of interdisciplinary modules centred on student-led research. Three new modules were launched: *Engagement and Participatory Practice*; *Social Entrepreneurship in Action: How to Create Social Impact and Change*; and *Global Connections (Online)*. These new modules demonstrate IATL's continued efforts to offer engaging, socially relevant modules that bring together students from different disciplines. IATL held a highly successful Module Fair in April, giving prospective students the chance to ask questions about our offerings, interdisciplinary methods and assessment innovations. As with previous years, there was a call for new module proposals, with Warwick staff encouraged to propose radically interdisciplinary learning designs that aligned with IATL's strategic aims (e.g. participatory practices, inclusive structures and care-rooted approaches).

IATL led in the assessment space with the development of a new traffic light system clarifying the use of AI on assignments (IATL, 2025), and the publication of an article in *Nature: Humanities and Social Sciences Communication* on the humanising potential of IATL's flagship 'student-devised assessments' (Riva *et al*., 2025). A new assessment method was developed to highlight how students on IATL modules are empowered to shape their learning journeys based on their unique interests and talents. Philosophy student Athena Rong-Hui said of her experience on *Navigating Psychopathology*, 'I learned a great deal about various subjects, including

biology, the arts, literature, and social sciences. Doing research for the essay [gave me] an opportunity to craft my own research question tailored to my interest, which spanned across Philosophy and psychopathology' (IATL, n.d.).

IATL pushed forward with its vision of a research-infused curricula centred on student agency, experimentation in assessment and visible student–staff co-creation. There were seven IATL student-led projects and twenty student co-creators involved on staff-led projects, including the LoCoR project, a two-year Education Fund initiative that unlocks the potential of undergraduate research for long-term, collective and interdisciplinary collaboration (Institute for Global Sustainable Development, 2025). A total of 117 IATL students wrote interdisciplinary and transdisciplinary abstracts as a formative task on their modules. Julie Derenne, an English literature student on the new IATL module *Your Idea, Your Research*, said of this opportunity: 'Writing my first interdisciplinary abstract as part of my IATL module helped me clarify the direction of my assessment project by thinking through potential findings and their broader relevance. Most importantly, it helped me see myself as a researcher communicating across disciplines, to any audience, regardless of their background' (IATL, n.d.). Nine IATL students presented assessed work at this year's ICUR event, two were funded to present at BCUR, and thirty-one exhibited their work in IATL's Assessment Exhibition – an incredible variety of research opportunities that were invaluable to students and demonstrate IATL's sector-leading commitment to supporting students.

IATL also 'infused' its curriculum with enterprise offerings with the launch of The IATL's Den, a student enterprise initiative that supported five students in advancing their entrepreneurial ideas by developing their assessed work into new ventures. Isaac Pilling, an IATL's Den participant and student on *Serious Tabletop Game Design and Development*, described it as 'an incredibly positive and formative experience' that left him 'feeling confident and energised to take [his] project to the next level' (IATL, n.d.). This example, taken together with those other examples from the academic year 2024/25, demonstrates recent examples of educational innovation and student-led practice. Fifteen

years on from its inception in 2010, IATL continues to innovate in assessment methods, inclusive education and embedding wellbeing in the curriculum.

‘Future trends’: 2030 and beyond

As the IATL community looks ahead to its 15th anniversary event, a new podcast series and more adventures in enterprise-infused education, the department continues to listen to and learn from our students, who remain the heart and soul of the Institute. This final section of the essay will speculate on future trends in higher education between the date of publication (2025) and the emerging decade (2030s); we imagine that:

1. AI will likely continue to redefine educational practice in significant ways, especially in relation to assessment methods and personalised feedback. Its rapid development presents challenges, risks and opportunities for universities. One central concern will be academic integrity: how can educators design assessment that meaningfully reflects the learner’s own thinking when AI can generate immediate answers? Alongside this is a broader question about the value of higher education itself, within the context of a rapidly evolving digital culture. As generative AI becomes more capable, some prospective students will understandably ask, and may already be asking, ‘Why attend university if I can access information, explanations and feedback from AI for free?’ These questions make it clear that higher education cannot continue with a ‘business as usual’ model, and most educators will recognise the need to adapt.
2. Access and participation will remain a key priority for universities, as government policy becomes more closely linked to learning outcomes and graduate prospects. There are several issues to unpack here, from universities needing to join up approaches to inclusive education, diversity and equity initiatives with curriculum and assessment reviews, as well as new investments in the built environment as a place of ‘belonging’. The academic systems that underpin teaching, learning and assessments processes will also need to be transformed, not only to cater for a more flexible, distributed student body but also to enable and incentivise student mobility across disciplines and, where possible, between institutions.
3. Students-as-leaders and decision makers will become a pressing concern for institutions that are keen to enact positive change in order to anticipate the needs of future students and to review the impact of university policies before they implemented. For many years, elected Student Union Officers and representatives have served within university structures across committees and have campaigned for change via direct action. One long-anticipated change, which may indeed finally come to pass in the 2030s, will be students taking charge of their own learning systems, making decisions in partnership with teaching staff, and co-developing research projects to benefit the wider society. In short, the future of higher education may, in fact, require new models of student identity and student-led policy change.

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