

TechMate: Translating Gender Equality Research into Actionable Practice for Computing Educators

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Abstract: The persistent underrepresentation of women in computing higher education remains a global challenge, with women comprising less than 20% of ICT specialists across the EU. While substantial research has identified effective interventions to support underrepresented groups, this evidence remains fragmented across academic publications, grey literature, and institutional reports. Educators seeking to implement gender-inclusive practices face significant barriers in identifying relevant initiatives, understanding implementation requirements, and accessing practical guidance suitable for their institutional contexts. This work presents TechMate, a fully operational (<https://ascnet.ie/techmate/>) web-based, open-access toolkit designed to bridge the gap between research evidence and practical implementation. The toolkit consolidates over 25 research-driven gender equality initiatives organised across four evidence-based strands: *Policy*, *Pedagogy*, *Influence & Support*, and *Promotion & Engagement*. Each initiative is presented as a discrete action with comprehensive implementation guidance, including research-driven supporting facts (Quick Facts section), step-by-step implementation approaches, institutional case studies, evaluation recommendations, and ready-to-use resources. The toolkit provides multiple pathways for educators to discover relevant initiatives: manual navigation through actions, or dynamic search and filter functionality tailored to institutional roles and resource availability. Individual action pages aim to guide users through the initial exploration, implementation planning and evaluation design. Actions range from in-class interventions (such as personalised feedback and intelligent class management) to strategic policy-level changes (including curriculum redesign and recruitment strategies). TechMate is designed for computing academics, programme leaders, and institutional diversity champions seeking evidence-informed guidance to improve recruitment and retention of women and other underrepresented gender groups in computing-related study programmes. The toolkit has undergone an evaluation with computing educators across multiple universities, demonstrating strong perceived usefulness and usability. The paper outlines the development of TechMate from prototype to current version and discusses toolkit's evaluation outcomes.

Keywords: Gender equality, Computing education, Women in technology, Best-practice toolkit, Evidence-based practice, Diversity and inclusion

1. Introduction

The underrepresentation of women in computing education persists globally despite decades of intervention efforts. In the European Union, women represent less than 20% of ICT specialists, with even lower representation in technical computing roles (Eurostat, 2025). In Ireland, only 25% of students in ICT-related third-level programmes in 2025 were women (HEA, 2025). Gender imbalance in computing has deep systemic roots extending far beyond higher education, including stereotypes (Cheryan et al., 2013), cultural factors (Frieze and Quesenberry, 2019), values and interests shaped from early educational experiences (Beyer, 2014). While third-level interventions cannot fully resolve these issues, computing educators have both responsibility and agency to implement evidence-based initiatives within their sphere of influence.

Research has documented numerous effective initiatives for supporting women and other underrepresented groups in computing education (Brodley et al., 2022, McKeever and Lillis, 2021; Siegeris, 2021). Perez-Felkner et al. (2024) show that although numerous gender-equality computing interventions exist and many demonstrate measurable success, most remain small-scale, unevenly evaluated, and poorly disseminated, limiting their translation into widespread practice and thereby sustaining gender disparities. Additionally, the evidence of success remains scattered across academic journals, conference proceedings, institutional reports, and grey literature. Research on gender disparities in computer science highlights a wide range of interacting psychological, pedagogical, and contextual factors, making it difficult for educators to identify which interventions are most appropriate or how they should be implemented within specific institutional settings (Beyer, 2014).

This paper presents TechMate, an evaluated, open-access web-based toolkit designed to translate research evidence by collating gender initiatives available and presenting them as an accessible, actionable guidance for computing educators who are aiming to implement gender balance improvements. The principal contribution is the toolkit itself, addressing the gap between fragmented research evidence and practical implementation in computing higher education. The paper is structured as follows: Section 2 reviews existing work, Section 3 describes the development process, Section 4 covers the architecture and navigation, Section 5 presents the evaluation, and Section 6 concludes with directions for future research.

2. Related Work

Various frameworks and toolkits address gender equality in computing education. The National Center for Women & Information Technology (NCWIT) developed the Undergraduate System Model (NCWITb, 2025) and Engagement Practices Framework (NCWITa, 2025). The former helps departments diagnose structural and cultural factors affecting participation, while the latter compiles research-based instructional and programme practices shown to improve inclusion. However, these resources function as conceptual guidance rather than an integrated implementation toolkit, requiring users to interpret, adapt, and operationalise recommendations across multiple documents and contexts. An additional tool, the Participant-Centred Planning Framework (Taylor-Smith et al., 2022) helps champions design and evaluate individual gender balance activities with structured checklists and participant-centred guidance, with a focus primarily on role model related activities.

International organisations have developed broader gender equality toolkits targeting policy-level interventions, including the European GEAR Action Toolbox (EIGE, 2024) and UNESCO's Resource Pack for Gender-Responsive STEM Education (UNESCO, 2017), which provide checklists, strategies, and exercises for institutional and classroom-level interventions. Disciplinary guides provide frameworks for computing-specific contexts (Moréda-Pozo et al., 2020; Spieler and Girvan, 2025), while localised toolboxes have been developed by individual institutions (NTNU, 2020; GENDIM, 2024). Informal learning communities and clubs also offer practical toolkits, such as CoderDojo's gender balance resources (CoderDojo, 2025), CAS's Inclusive Computing Resources (CAS, 2025), Girls Who Code and R-Ladies starter kits, which provide activity-based guidance and mentoring strategies (Girls Who Code, 2025; R-Ladies, 2025).

These existing resources offer valuable guidance but present limitations. Many provide high-level strategic frameworks without detailed implementation specifics (EIGE, 2024; NCWITa, 2025; OECD, 2023). Some target specific institutional/topical contexts, limiting transferability (GENDIM, 2024; NTNU, 2020; Taylor-Smith et al., 2022). Others lack direct connections to supporting research evidence (NCWITa, 2025) or while being practical, provide limited direct guidance for institutional implementation (CAS, 2025; Girls Who Code, 2025; R-Ladies, 2025). TechMate addresses these gaps by combining evidence-based initiatives, categorisation to support exploration, practical implementation guidance, direct research links, and context-adaptable resources in a single platform (TechMate, 2026).

3. Approach

TechMate is an open-access web-based toolkit. The primary target audience includes academic leads, lecturers and champions for gender equality in computing higher education sector. TechMate's development followed ISO 9241-210:2019 with human-centred design principles (ISO, 2019): design based on explicit understanding of users, tasks and environments; user involvement throughout development; design driven and refined by user-centred evaluation; iterative processes; addressing the whole user experience; and multidisciplinary design perspectives. This section describes the process through which research evidence was translated into a functional toolkit.

3.1 Core Structure of TechMate

Defining a core structure of TechMate, which shaped the information architecture of the toolkit, involved a multivocal review (Garousi et al., 2019) of academic and grey literature addressing gender imbalance in computing education. The review encompassed academic publications, institutional reports, practitioner resources, and policy documents from diverse geographic and linguistic contexts overall including over 400 sources. This approach captured valuable initiatives existing outside traditional academic channels. Each identified practice was analysed for evidence of effectiveness, contextual requirements, and implementation feasibility. Practices were categorised into four evidence-based groups of initiatives (called actions): *Policy*, *Pedagogy*, *Influence & Support*, and *Promotion & Engagement* (Berry et al, 2022) with relevant subgroups, as displayed in Figure 1.

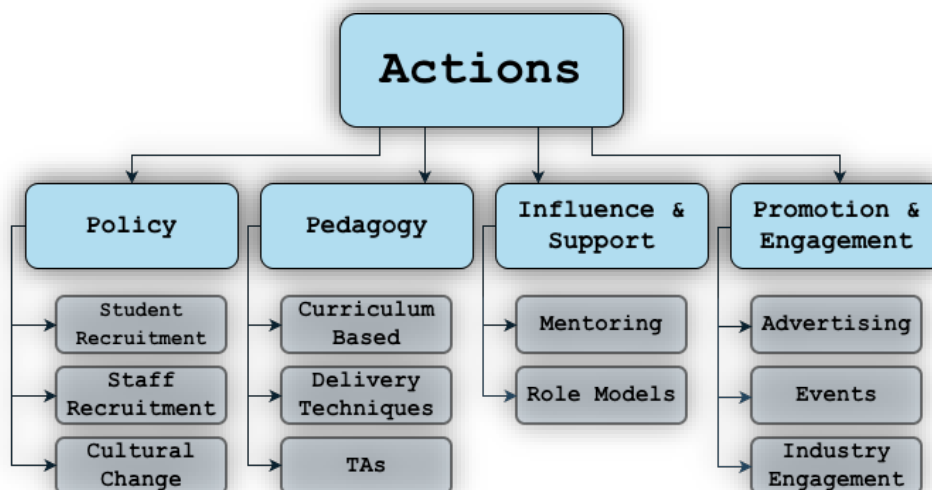


Figure 1: Categorisation of gender balance initiatives, adapted for the toolkit from Berry et al. (2022)

Policy actions require organisational-level support and potentially structural change. Subcategories are Student Recruitment Strategies, Staff Recruitment, and Cultural Change. Examples of policy actions include, gender-balanced staff recruitment, student awards programmes, marketing material redesign.

Pedagogy actions relate to curriculum, module delivery, and assessment practice. Subcategories include Curriculum Based, Delivery Techniques, and Teaching Assistants (TAs). Examples include hybrid programmes, personalised feedback in computing assignments, use of undergraduate/Al teaching assistants.

Influence & Support actions focus on inspiring women to choose computing and supporting persistence once enrolled. Subcategories are Mentoring and Role Models. Examples include buddy systems, peer mentoring programmes, industry and teaching role models.

Promotion & Engagement actions involve outreach to external stakeholders including schools, industry, and communities, as well as highlight how computing courses can be advertised to attract underrepresented gender groups in computing. Subcategories are Advertising, Events, and Industry Engagement. Examples include promotional material development, school outreach events, industry partnership sessions.

This categorisation helps educators and institutions identify which types of initiatives are feasible given their resources and constraints, guide where they want impact, and is flexible to the role of the person using the toolkit (lecturer vs. head of school).

3.2 Design Principles

Five context-specific design principles were defined for TechMate. First, *accessibility over gatekeeping* ensures research-based knowledge reaches users from the intended target audience and beyond who can benefit through registration-free access. Second, *action-orientation over theory* prioritises practical implementation guidance with ready-to-use templates, and evaluation instruments. Third, *evidence-based yet pragmatic* approaches transparently ground each action in published research with direct citation links while acknowledging contextual variation and providing flexible implementation guidance users can adapt to local contexts. Fourth, *user-centred design* accommodates diverse user types: individual lecturers, department heads, policy makers, with varied needs and familiarity levels through multiple navigation pathways and contextual filtering. Fifth, *aesthetic professionalism* ensures visual credibility and usability through clean, responsive design.

Research on educational innovation adoption identifies persistent implementation barriers, including time constraints and workload pressure (Brownell and Tanner, 2012; Henderson et al., 2011; Walczyk et al., 2007), limited institutional support (Brownell and Tanner, 2012; Henderson et al., 2011), uncertainty about effectiveness (Brownell and Tanner, 2012; Henderson et al., 2011; Prince, 2004), difficulty adapting to local contexts (Brownell and Tanner, 2012; Coburn, 2003; Henderson et al., 2011), cognitive overload and decision fatigue (Mayer, 2017; Sweller, 1994;), and lack of practical translation from theory to action (Levin, 2013; Nutley et al., 2007). TechMate's design principles directly address these barriers: modular action structure creating an action's page for even a small, potentially lightweight initiative enables selective adoption within available time

and resources; different categories of actions help users identify initiatives feasible within their authority level; transparent research grounding addresses uncertainty about effectiveness; implementation guidance that uses case studies from around the world supports adaptation to local contexts; structured navigation with consistent visual organisation reduces cognitive load and search effort; and templates with concrete guidance provide actionable resources. With the principles established as the design foundation, the following section describes how they were implemented through iterative development and prototyping process.

3.3 Development and Iterative Evaluation

A five-stage development process translated the initiative categorisation into a fully functional prototype. Stage 1 established the information architecture through structural sketching; Stage 2 tested navigation logic and content grouping via low-fidelity hand-drawn wireframes; Stage 3 inserted representative content into the design using Elementor on WordPress; Stage 4 gathered iterative feedback from eight users (specialist and non-specialist) through email, Microsoft Forms, verbal discussion, and accessibility checks; Stage 5 finalised visual styling, typography, colour schemes, and hyperlinks. A preliminary review of the interface of one page with ten TU Dublin lecturers revealed both strengths and areas requiring improvement (old vs. new version of the page is displayed in Figure 2). Participants valued the evidence-based approach, practical templates, and comprehensive evaluation guidance. However, critical usability issues emerged including dense text requiring bullet-point summaries, clunky layout with problematic contrast, small hard-to-read fonts, and insufficient immediately reusable resources. Lecturers specifically requested ready-to-use survey instruments rather than just references to published studies, visual summaries to complement text, and clearer navigation. These findings directly informed the substantial toolkit redesign including platform migration from Elementor to Divi, improved visual hierarchy and contrast, restructured layouts with progressive disclosure, larger readable text, and enhanced accessibility features. The new page (Figure 2) demonstrates improved colour contrast of the toolkit, more conventional use of fonts to improve readability, improved organisation of the information by displaying navigation on the left with content on the right and adding a specific section with downloadable resources.

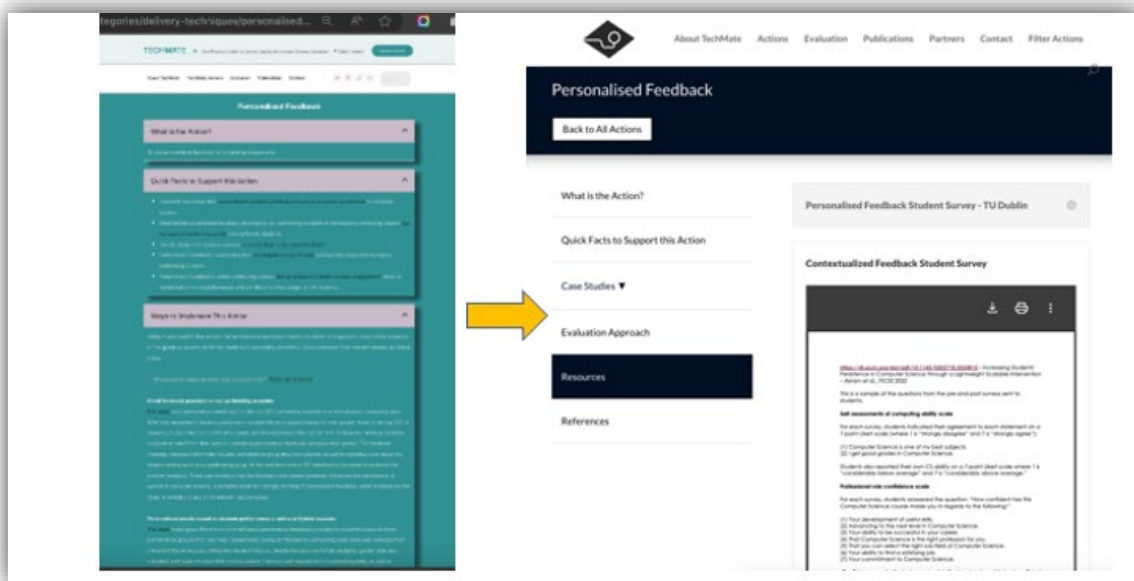


Figure 2: Personalised Feedback action's page old design vs. new, improved version

Accessibility features were designed with reference to WCAG 2.1 Level AA targets (WCAG, 2018), though initial automated checks and subsequent screen-reader testing revealed issues requiring ongoing refinement through custom accessibility plugins. Google Analytics 4 tracks usage with privacy-respecting configuration ensuring GDPR compliance.

4. TechMate’s Information Architecture and Navigation

The toolkit's information architecture implements the four-strand categorisation for actions pages as established in Section 3.1. A diagram with the overall website structure is displayed in Figure 3. The Actions landing page, which is the focus of the toolkit, presents an interactive side menu displaying all four categories (as shown in Figure 4) and their respective subcategories. Currently there are 25+ actions on the website. This section describes the individual action page structure and the navigation/search logic.

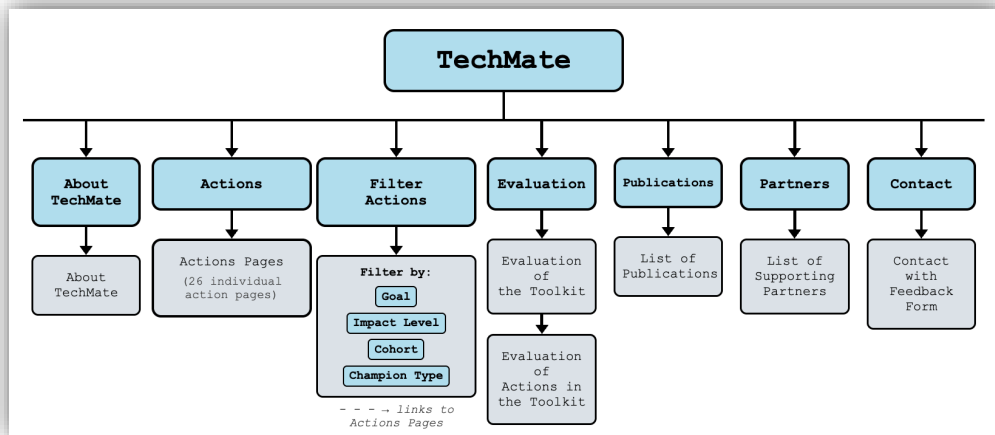


Figure 3: Structure of pages in TechMate

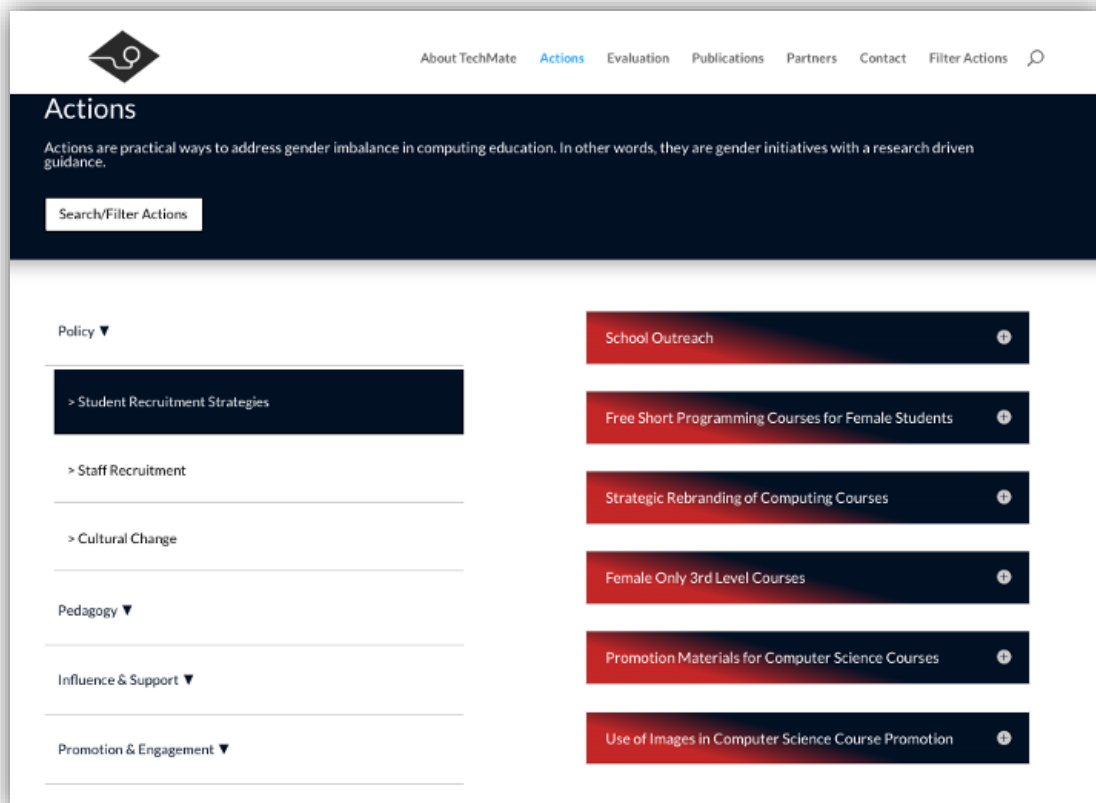


Figure 4: TechMate’s Actions landing page

4.1 Action Page Structure

Each action page follows a standardised structure designed to support informed decision-making (an example of Buddy Systems' page is displayed in Figure 5):

- *What is the Action:* Concise description of the action and links to related actions where appropriate.
- *Quick Facts:* Research-derived quotes and findings supporting the rationale for the implementation , with direct links to citations.
- *Ways to Implement This Action:* Implementation approaches/ideas informed by research evidence and institutional case studies, where applicable.
- *Evaluation Approach:* Guidance for assessing the impact of the initiative, including ready-to-use survey instruments where available.
- *Resources:* Templates with ready-to-use guides or questionnaires, where available.
- *References:* Direct links to supporting academic publications and practitioner resources.

4.2 Navigation and Discovery

TechMate provides two ways of discovering relevant initiatives, accommodating different user preferences and expertise levels: the category-based navigation, and the filter-based search.

The Actions landing page presents all initiatives organised by category and subcategory. Users explore categories through an interactive left-side menu as discussed earlier and presented in Figure 4, with relevant actions displayed in the main content area. This approach suits first-time users and those seeking comprehensive understanding of available initiatives. Tooltip descriptions provide contextual information about each category and subcategory. Actions may appear in multiple categories where contextually appropriate (e.g., School Outreach appears in both Student Recruitment Strategies and Events).

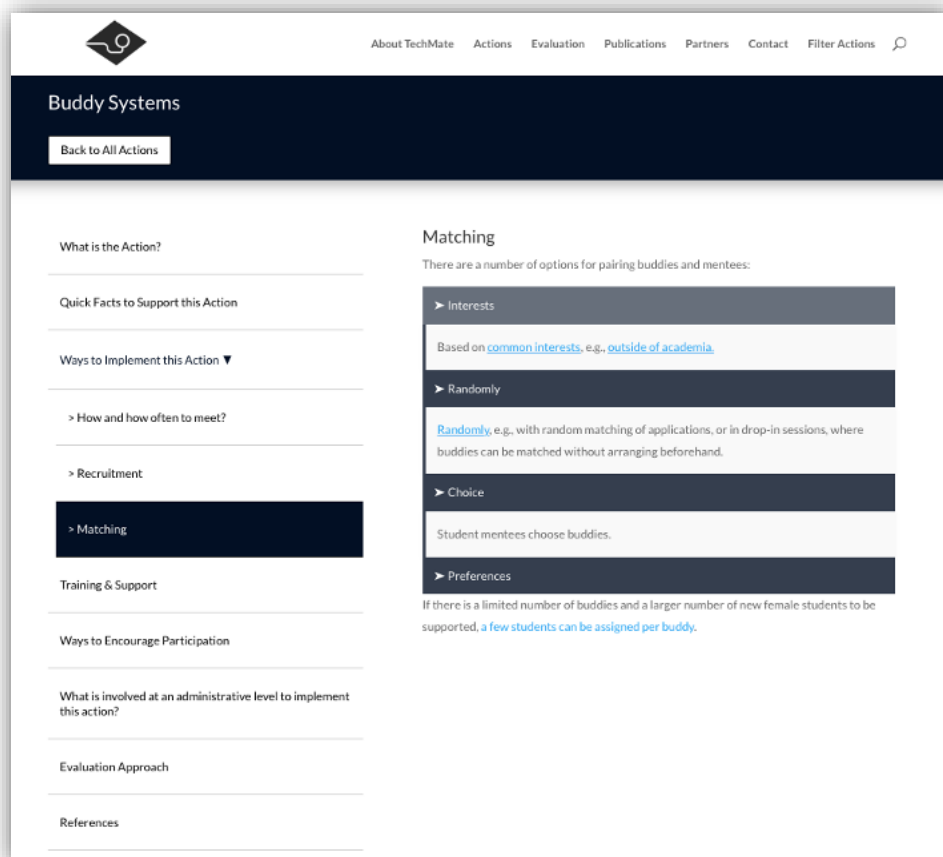


Figure 5: Buddy Systems action page

The Filter Actions page (Figure 6) enables targeted search. Users specify criteria across four dimensions:

- *Ultimate Goal*: Student recruitment or retention
- *Level of Impact*: Short-term or long-term initiatives
- *Student Cohort Targeted*: New students, undergraduate students, or postgraduate students
- *Role Required*: Lecturer, Manager, Policy Maker, or Other

This functionality supports returning users and those seeking initiatives matching specific user goals or needs.

5. Evaluation of TechMate

This section describes the evaluation design, participant sample, and findings for both perceived usefulness and usability of TechMate.

5.1 Methodology

The TechMate evaluation used a mixed-methods approach examining perceived usefulness and usability. Usefulness was operationalised through four theory-driven attributes — *novelty*, *relevance*, *trustworthiness*, and *actionability* — aligned with Perceived Usefulness (Davis, 1989) and Performance Expectancy (Venkatesh et al., 2003). Usability was assessed via effectiveness, aesthetics, navigation, terminology (Nielsen, 1993; Norman, 2013), and user satisfaction (ISO, 2018), collectively informing Perceived Ease of Use (Davis, 1989). Eighteen computing educators (11 women, 7 men) from eight Irish universities participated in facilitated observational sessions of 30–90 minutes. Using a think-aloud protocol, participants completed two tasks — identifying an immediately implementable initiative and selecting the most promising initiative assuming unlimited resources — followed by semi-structured interviews. Transcripts were analysed through extraction of 869 deductively coded meaningful units assigned to predefined attributes, and 158 inductively coded units capturing emergent themes (Braun and Clarke, 2006). Three independent coders scored each unit on a 5-point Likert scale, with scores averaged per participant per attribute.

Transcripts underwent systematic analysis through three complementary methodological phases, ensuring both depth and reliability of findings. Meaningful units—coherent textual segments capturing discrete ideas relevant to the evaluation objectives (Braun & Clarke, 2006) — were extracted first. Each unit represented a single, complete thought from participant discourse. This process resulted in 1027 units, with 869 then being deductively assigned to the predefined usefulness or usability attribute. Three coders independently scored each unit on a 5-point Likert scale (with 1 – “Very Negative” to 5 – “Very Positive”), with a discussion that followed between the coders to resolve ambiguities. Scores were individually averaged per participant per attribute. Finally, remaining 158 units were coded inductively using thematic analysis by Braun & Clarke (2006).

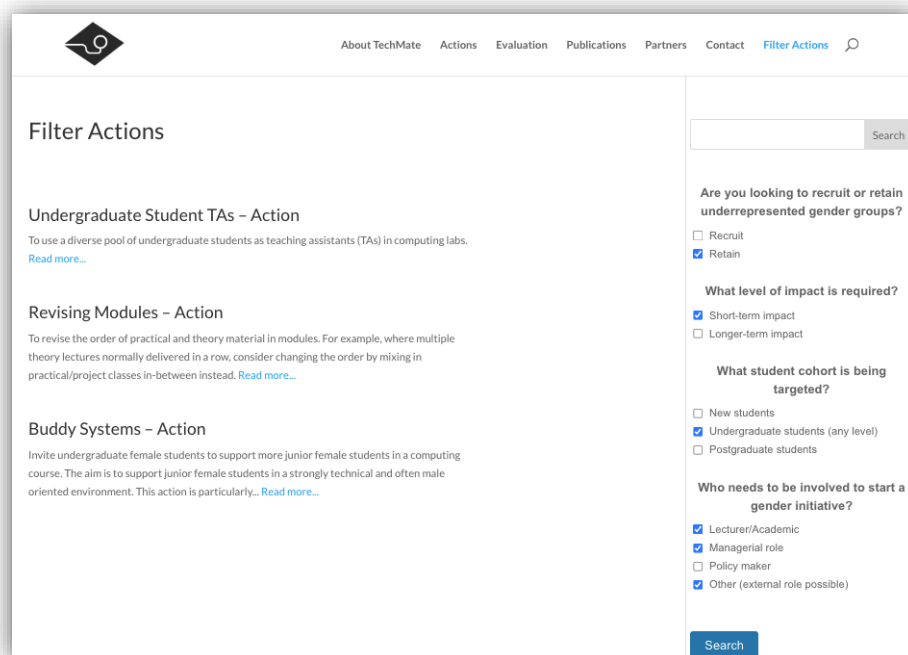


Figure 6: Filter Actions page with sample results

5.2 Results

Participants selected 18 of the 26 available initiatives (69%), demonstrating broad relevance across roles ranging from junior lecturer to academic leader. Action selections clustered strongly around low-cost, immediately implementable practices. The most frequently chosen initiatives were Gender Balanced Participants at Computing Events, Class/Lab Setup, Family Friendly Course Schedule, and Buddy Systems. Table 1 presents the key frequency distribution of selected actions. Notably, 28% of participants (n=5) made unprompted statements indicating intent to implement a selected action immediately or within weeks, without requiring institutional support or additional budget. 44% (n=8) expressed clear implementation intent.

Table 1: Key action selections: frequency and implementation context (n=18)

Action	Category	n	%	Why it stands out
Gender Balanced Participants at Computing Events	Promotion & Engagement – Events	5	28%	Most frequently selected action overall; achievable by adjusting existing event recruitment with no additional budget
Class/Lab Setup	Pedagogy – Delivery Techniques	4	22%	Requires no policy change; within individual lecturer control
Buddy Systems	Influence & Support – Mentoring	4	22%	Low-cost support structure; can be built on existing student societies with no dedicated budget line
Short Meetings with First Year Students	Influence & Support – Mentoring	3	17%	Explicitly cited for immediate implementation by 2 participants; requires no budget or approval
Role Model Delivering a Guest Lecture	Influence & Support – Role Models	3	17%	Deliverable within existing timetable; potentially low cost
Family Friendly Course Schedule	Policy – Cultural Change	4	22%	Highest-selected policy action; requires institutional coordination but no direct budget

Quantitative evaluation showed consistently positive perceptions across all attributes. Actionability received the strongest feedback for usefulness, with 83% of participants rating it positively or very positively. Novelty and relevance were rated positively by at least 78% of participants, and trustworthiness by 72%, largely attributed to the inclusion of research citations. Usability attributes received positive ratings from approximately two-thirds of participants, with 95% reporting positive overall user satisfaction. Qualitative analysis further revealed that participants valued TechMate as a tool for overcoming practical barriers such as time constraints, institutional resistance, and student isolation, by providing concrete implementation examples, ready-to-use evaluation templates, and peer-reviewed evidence to support advocacy within their departments.

This evaluation carries limitations. The sample of eighteen computing educators exclusively from Irish universities is relatively small and geographically narrow; findings should therefore be interpreted as indicative rather than generalisable across broader institutional or cultural contexts.

6. Conclusion and Future Work

TechMate provides computing educators with a consolidated, research-driven starting point for gender equality actions, structured to reduce the effort of identifying and implementing relevant initiatives. Educators consistently identified initiatives they could act on within their existing roles, with many expressing unprompted intent to implement specific actions immediately. The toolkit's value lies not only in consolidating over 400 sources, but in translating that evidence into a form educators recognise as directly usable. Future work will prioritise a longitudinal study of implementation uptake, expansion of case studies beyond Irish institutions to address the current evaluation's geographic limitations, and a straightforward community contribution mechanism enabling practitioners to share implementation experience.

Ethics Declaration: Ethical approval was obtained at TU Dublin for the evaluation of the toolkit (TechMate Evaluation study).

AI Declaration: Generative AI tools assisted with formatting of text in this paper. All research, analysis, findings, and intellectual content are the original work of the named authors.

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