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Best Practices from School to University

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EUGAIN features more than 160 members from over 45 countries, including 5 non-European ones. Its main aim is to improve gender balance in Informatics through the creation and strengthening of a truly multi-cultural European network of academics working at the forefront of the efforts in their countries, institutions and research communities. It builds on their knowledge, experiences, struggles, successes, and failures, learning and sharing what has worked and how it could be transferred to other institutions and countries.

Informatics Europe, the Grant Holder institution of EUGAIN COST Action, unites and empowers the Education & Research Informatics community across Europe. It connects over 50,000 researchers from 200+ member institutions spanning 30+ countries. The organisation advocates for shared priorities and supports policy making in Education, Research and the Social Impact of informatics in Europe. EUGAIN builds upon the groundwork laid by the Informatics Europe Women in Informatics Research and Education (WIRE) Working Group, which has since evolved into the Diversity & Inclusion Working Group. More information: www.informatics-europe.org

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Introduction

Data on gender distribution in education, employment, and career shows that Informatics is a male-dominated sector. Although technology is similarly available to adults and children of all genders, women remain under-represented in both academia and industry careers related to Informatics. The different roles that families and societies impose on individuals based on gender may be considered the primary reason for the under-representation of women in the field of Informatics. The ongoing representation of women in Informatics is unsatisfactory, particularly in ensuring the realisation of gendered innovations that address the needs of all citizens. The low percentage of female employees working in the technical departments of the largest technology companies, for example, eBay, Twitter, and Google can be one of the indicators of how they are represented in the field. For example, according to the Statista report, 58% of the employees in the technology department of e-Bay are male (Gelder 2023; Dixon 2024; Bianchi 2023). Similar numbers for Twitter and Google are 67.1% and 75%, respectively. These gender ratios show that, despite the availability of tools and technology that families provide for their kids and/or the equal possibilities provided to pupils in schools, this scenario has not been mirrored in women's jobs.

Families' behaviours, attitudes, and perspectives on gender stereotypes are crucial indicators of their children's participation in any activity (Simpkins, Davis-Kean, and Eccles 2005; Vekiri and Chronaki 2008). It is possible to say that the different support or attitudes of families between genders will have an effective impact on their children's education and even their careers. Even though the financial opportunities offered to children of different genders are the same, and technology is similarly available to adults and children of all genders, still (Eccles 2015) states that parents spend more time with their sons than with their daughters engaging in technology-related situations.

The first barrier encountered by girls on their way to entering the world of Informatics is at the school level. According to the literature, female students frequently assume they are not good enough and are less experienced than their male counterparts. Therefore, they disregard Informatics as not being appealing to them. This negative attitude is a consequence of entrenched gender stereotyping in society and family where Informatics is considered a male discipline.

We argue that starting to work on girls' attitudes toward technology and triggering their curiosity and passion for Informatics from early education is a way to foster changes leading to a better gender balance in Informatics. The number of women in the Informatics field will increase naturally if female students in the first stage of formal education (primary and secondary school) are better supported and actively encouraged to consider Informatics as a rewarding and satisfactory future career. In this booklet, we have highlighted issues, obstacles, best practices for attracting more girls to Informatics, and recommendations for enlisting and keeping female students to assist in their efforts to implement initiatives to attract more girls to Informatics.

Note: We opted for a gender-sensitive bibliography style: to increase visibility we have cited women and men by including their first name in full.

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How can we attract more girls to Informatics: problems and strategies

The underrepresentation of women in Informatics higher education and, consequently, in the Informatics industry, is largely tied to practices in primary school education. It has been reported that gender stereotypes and social expectations strongly discourage girls to consider and pursue Informatics (Szlávi and Bernát 2021; Happe and Buhnova 2022).

Young women's barriers to engagement in Informatics education and careers, however, are also linked to the classroom (Happe, Buhnova, et al. 2021; Szlávi 2021). The attitude of teachers and classmates, the curriculum and learning environment, insufficient knowledge regarding the myriad of jobs available within the IT job market, and what competencies such jobs require lead to the critically low number of girls choosing Informatics courses at university.

In this section, we introduce the significant reasons girls do not choose Informatics and the strategies and suggestions to remedy this social, educational, and economic problem.

Major Reasons Behind The Problems

Recent studies and interviews conducted by EUGAIN's working group 1 during meet-ups with initiatives helping girls with coding, show that the major reasons can be categorised under the headings of stereotypes, access, confidence, sense of belonging, and isolation topics (Happe and Buhnova 2022):

(a) **Access**

- The first hole in the leaky pipeline on girls' pathway towards Informatics is linked to the missing access to encouragement and support, together with the access to suitable education that should build on the many different interests of girls that often span multiple disciplines.
- Lack of relatable and engaging Informatics education: Girls have less interest in Informatics because they start to use computers later than boys, and they use them generally for homework, socialising, research, etc. Therefore, boys already have more experience. This makes girls stay behind boys regarding computer literacy.

(b) **Stereotypes**
Close family and friends often direct girls away from Informatics to protect them from a future where they cannot imagine the girls becoming successful. This shows how important it is to help families, especially mothers, understand that software engineering can be a great career choice for their daughters.

- Stereotypes held by themselves: Gender roles change according to the culture. However, gender roles are given to women by society or cultures, like being a housewife or having fewer active roles in business life to take better care of the house and children, which affects women while choosing their careers.
- Stereotypes held and communicated by their families: Families have a significant role in shaping their children's careers. Because of the lack of knowledge, sometimes families can think Informatics is a hard, or even somehow unsafe, discipline for girls to engage with. Therefore, they are not supportive of an Informatics career.

- Stereotypes held and communicated by their teachers: Teachers influence student's lives. Because of their lack of confidence or knowledge, they can be unsupportive of girls in Informatics or be more supportive of male students without being aware of it.
- Lack of alternatives to stereotypes in the form of relatable role models: When girls can't see or reach relatable role models as teachers in Informatics or successful professionals in informatics-related stereotypical images and messages can reduce girls' sense of belonging.

(c) **Confidence**
When girls find themselves in the classroom, often surrounded by more experienced learners (typically boys), they feel less confident. It can be hard to fall into the category of a slow novice learner for little girls who often excel in other subjects. This leads them to leave the stage to boys at computer labs, courses, etc.

(d) **Sense of Belonging** The girls who resist the earlier three challenges continue their education in Informatics and find themselves in classrooms surrounded predominantly by boys. This can make them feel they don't belong there.
Girls need to feel safe in learning environments. If the learning environment is not female-friendly, or perceived as hostile to their way of expressing themselves and achieving understanding, they won't feel competent. Isolation: Isolation is a symptom of the relatively small number of female students enrolled in Informatics degree programmes.

- This can have a significant negative impact on female students when there appear to be few role models and peers (Stevenson 2020).
- The larger numbers of male students, especially when the tutors and lecturers are also likely to be male, increase the likelihood that lectures and large lab and practical sessions are dominated by male students, reducing the chances of equitable participation by female students.
- This can be compounded if the student cohort is further divided into smaller groups for a computer lab and practical sessions when the already small female student population is dispersed among many different groups or classes.
- When students also lack self-confidence, then the chances of becoming isolated increase. Increased isolation is inversely proportional to a sense of belonging, and a sense of belonging is one of the most significant indicators of student progression.

Strategies and Suggestions

According to the recent studies in the literature and the interviews we conducted during our meet-ups with initiatives helping girls with coding, we devised suggestions to address major problems by following the strategies reported in (Happe, Buhnova, et al. 2021; Happe and Buhnova 2022) as detailed below:

(a) **Strategies and suggestions for access problem:**
Strategies:

- Digital gaming and creative arts activities designed for girls (Main and Schimpf 2017; Milam 2012).
- Start with online contextualised activities (Garcia-Penalvo et al. 2016; Menon, Romero, and Viéville 2020.

- Visual programming environments to teach introductory programming (Menon, Romero, and Viéville 2020; Siiman et al. 2014).
- Involve discussion and reflections on the activities (Garcia-Penalvo et al. 2016).

Suggestions:

- Early contact with computers or computing: Providing early contact (starting from at least kindergarten) through visual programming environments to teach introductory programming or game-based activities helps engage girls.

(b) **Strategies and suggestions for the stereotypes problem:**
Strategies:

- Provide girls with non-stereotypical examples to aspire to by showing them successful and relatable female role models in Informatics (Boston and Cimpian 2018; Nash 2017).
- Portray work in computing as helpful, altruistic, and community-oriented (Boston and Cimpian 2018).
- Provide opportunities to do Informatics activities as part of a group (Boston and Cimpian 2018; Brotman and Mensah 2008; Nash 2017).
- Include physical reminders of women's success in Informatics (Boston and Cimpian 2018).
- Educate teachers by providing them with tools and approaches to better engage girls (Brotman and Mensah 2008; Crick 2017; Nash 2017).

Suggestions:

- Supportive families: Families should be informed about education in Informatics, made aware of the opportunities it brings, and reassured it is open to all genders. Since families often unintentionally promote stereotypical views about Informatics (e.g. Informatics is just for boys), it is advisable to plan educational events to increase their awareness. Parents can be encouraged to take their daughters to events and excursions, and share with them stories and role models from the history of computing to support children in their awareness of negative gender stereotypes.
- Encouraging teachers: Together with actively supporting the girls in their classes, by giving them more attention and rewarding their multidisciplinary interests, teachers could use tools that have been developed and studied to support children in their awareness of negative gender stereotypes.
- Approachable and relatable role models: Role models should be approachable and relatable to girls. They could be university students or women entrepreneurs.

(c) **Strategies and suggestions for access problem:**
Strategies:

- Provide low-stakes opportunities for girls to experience success (Boston and Cimpian 2018; Nash 2017).
- Install as a growth mindset the belief that abilities can be improved with effort, strategies, and mentoring (Boston and Cimpian 2018).
- Adopt a positive, constructive attitude toward failure as a valuable learning opportunity (Boston and Cimpian 2018).

- Provide long-term self-directed projects (Brotman and Mensah 2008).
- Split classes by experience.

Suggestions:

- All-girls classes or classes split by experience: All-girls classes or classes split by experience make girls feel safe, build confidence to experiment, and express their creativity.

(d) **Strategies and suggestions for the sense of belonging problem:**
Strategies:

- Emphasise the social impact and interdisciplinary nature of working in Informatics (Brotman and Mensah 2008; Crick 2017; Garcia-Penalvo et al. 2016; Murphy et al. 2019; Siiman et al. 2014).
- Utilise/create interesting and engaging real-world inquiry-based open-ended hands-on experiences (Brotman and Mensah 2008; Main and Schimpf 2017; Nash 2017; Siiman et al. 2014).
- Promote community and being part of group (Boston and Cimpian 2018; Brotman and Mensah 2008; Nash 2017).
- Create a non-competitive environment (Boston and Cimpian 2018).
- Prefer collaborative assignments (Boston and Cimpian 2018; Brotman and Mensah 2008; Nash 2017).
- Offer all-female education programmes and classes.

Suggestions:

- Project-based and multidisciplinary activities: More emphasis on the process of thinking, designing, and problem-solving than the actual coding (IT is a part of daily life).
- Non-stereotypical Learning Environment and Advertisement: Avoid stereotypes in the learning environment by, e.g., balancing the number of technical posters in the room with non-technical posters; posters containing images of people should be gender-balanced; using bright colours (not only dark/black coding colours); using people and not just technology/equipment in advertisement material.

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Best practices in primary school curriculum to encourage female students: in class and after school activities

Recently, primary and secondary schools have been trying to make an effort to integrate Informatics into their curriculum as more jobs require programming and algorithmic thinking skills in the future. The necessity to educate Informatics at a young age stems from the fact that it naturally enhances numerous skills, including problem-solving, creative thinking, and algorithmic/computational thinking, preparing students for any field of study or job. Researchers believe that because Informatics has the potential to become the focal point of a technologically evolved society and the world, every student should have the chance to engage with it (Wang, Hong, et al. 2016; Goode 2008; Wang and Hejazi Moghadam 2017; Haynes et al. 2022). Despite the growth of teaching Informatics in primary and secondary schools and its popularity as a chosen field in academia, the number of female students is still a minority. The reasons why women are underrepresented in Informatics have been discussed by many scholars (Mejias et al. 2019; Rankin, Thomas, and Erete 2021; Hoffman, Morelli, and Rosato 2019; Phelps and Santo 2021). There are great examples of women in Informatics, such as Ada Lovelace, who wrote the first algorithm, Grace Hopper, who defined the COBOL language, a female team made of Jean Bartik, Betty Holberton, Marlyn Wesco, Kathleen McNulty, Ruth Teitelbaum, and Frances Spence handled the programming side of the first programmable computer ENIAC, so without them, we would not have the technology we have today. To achieve gender diversity in Informatics, women should be encouraged at an early age to choose Informatics. This part of the booklet will focus on the best practices in primary and secondary schools to empower and encourage female students to study Informatics.

School Curriculum:

The need to integrate Informatics into the primary and secondary school curriculum has been gaining significance because of the digital era. Scholars agree that the way of teaching Informatics to students in primary and secondary schools is as important as its importance of being in the curriculum (Falkner and Vivian 2015; Goode 2008; Hubwieser et al. 2014; Falkner, Sentance, et al. 2019). Students' levels of learning, pedagogy, and interdisciplinary collaborative examples from real life are essential to facilitate education in Informatics (Goode 2008; Falkner, Sentance, et al. 2019; Wang and Hejazi Moghadam 2017). Carter 2006 states that the lack of a well-designed curriculum is one of the reasons that deter female students from studying Informatics. Phelps and Santo 2021 support the idea that the school curriculum should be revised and redesigned by including goals to welcome all students and to include extracurricular activities to attract female students' attention. This section will give primary and secondary school best practices in four parts by dealing with both in and out-of-class activities in kindergarten, primary school, secondary school, high school, and after-school examples.

- **Kindergarten:** Learning a skill at a young age is crucial for many reasons. Otterborn, Schönborn, and Hultén 2020 states that teaching Informatics concepts in early ages is important because it fosters the development of computational skills such as logical thinking, algorithmic thinking, decomposition, evaluating and abstracting. All necessary abilities for developing as people and achieving a high level of global awareness. Clarke-Midura et al. 2021 highlight that Informatics integration in kindergarten can be achieved with

unplugged activities which are based on card games, drawing or with professionally developed toys.

  - **In Class:** Unplugged activities should be integrated into the curriculum making students think abstractly. Sample examples:
    * Colour by numbers: Students are supposed to complete a given page by colouring the given binary numbers to see the complete picture. For instance, 10001 binary numbers will be given to students, and they'll be asked to colour only zeros to find the pattern.
  - **After School:** After school club curriculum on programming is created to attract attention to the world of programming.
    * Algorithm with toys: Students can make a toy move on a map according to the given orders. For instance; move your toy two steps forward to catch a strawberry.

- **Elementary School:** Studies show that Informatics is not only about learning fundamentals of computers and programming but it goes beyond it because of its natural link with other skills such as problem-solving, algorithmic thinking, creativity and so on (Clarke-Midura et al. 2021; Phelps and Santo 2021; Goode 2008), which are the 21st century skills. Since we live in a digital era and the new generation is called Digital Citizens, Informatics also plays an important role in elementary school. The activities below are given as the best practices at the elementary school level for the integration of Informatics into the school curriculum.

  - **In Class:**
    * Motivational posters are prepared by the students with the guidance of the Art, Social sciences, English and/or native language of the students to display in the school corridors to raise awareness about women in ICT on International Women Day.
    * The ICT-integrated English lessons and activities are prepared and conducted to prepare the students for real-life experience.
    * Interdisciplinary projects are organised to encourage students to use digital skills while learning.
    * STEAM activities are held yearly.
      · A collaborative event can be held. Schools should ask the teachers from different departments related to the STEAM field to prepare an event together. It can be planned as a competition. Each field may choose its challenges. Such events raise the motivation of female students.
  - **After School:**
    * Jr FLL: Junior FIRST LEGO League can be held. FIRST® LEGO® League introduces children ages 4-16 to science, technology, engineering and maths (STEM) in an engaging and fun way that promotes hands-on learning experiences. Through a dynamic global robotics programme, participants develop real-world problem-solving skills, helping students and educators work together for a better future.
    * Coding clubs can be organised.
    * After school club curriculum on programming is created to attract attention to the programming world.

- **Secondary School:** Secondary school plays an important role in moving programming type from unplugged and blocked to text-based with a written algorithm. Students in secondary schools start to learn problem-solving in math and science classes in a serious way, unlike in primary school (Jua, Sarwanto, and Sukarmin 2018; Simamora, Saragih, and Siregar 2018). The activities below are examples of how to have a smooth shift from block coding to text-based coding with activities that take students' attention from all genders.
  - **In Class:**
    * One encouraging success story of a female technology entrepreneur or inspiring female character in IT/ ITC per term is included in the school curriculum.
    * Leaflets are distributed to highlight female technology celebrities.
    * Interdisciplinary Collaborations are integrated into the curriculum.
  - **After School:**
    * International projects that can be virtually carried out are organised and conducted.
    * FLL: FIRST LEGO League can be held.
    * Bebras Challenges are organised.
    * After school club curriculum on coding is created to attract attention to the world of coding.
    * Summer school/camp is organised to expand the exposure of the ICT world to young learners.
- **High School:** Understanding the problems of why female students are under-represented in the field of Informatics, scholars mostly look for the answer at the high school level. Scholars expressed the reasons why females are feeling uncomfortable with Informatics during high school education as a limitation on access to programming experiences, male-oriented curriculum with abstract programming, lack of real-life integration, and implicit and explicit stereotyping by school stats (Fisher and Margolis 2002; Weston, Dubow, and Kaminsky 2019; Okoye et al. 2020). The activities below are given as the best practices at the high school level for the integration of Informatics into the curriculum. The goal is to integrate Informatics in all other subjects to show students Informatics is more than a computer or a programming language, so this will change the "geek" stereotype of male role models for female students.
  - **In Class:**
    * International projects that can be virtually carried out are organised and conducted.
    * Female coders/technology-related people are invited to schools to give motivational talks about positive discrimination.
    * Leaflets are distributed to highlight female technology celebrities.
    * Parents are informed and encouraged to guide their children to take part in the computing world. This will help female students to have support from their parents. Also, including parents in such activities will play a great role in encouraging their children to take up Informatics.
    * The counselling service of the school plans and conducts informative meetings with the female students (and their parents) to raise their awareness about the field.

- **After School:**
  - FRC: FIRST Robotics Competitions can be held.
  - WRO: The World Robot Olympiad can be held.
  - Science fair per term is organised to facilitate increased internet usage and technologies.
  - After school club curriculum on coding is created to attract attention to the world of coding.
  - Summer school/camp is organised to expand the exposure of the ICT world to young learners.
  - Promote after-school activities to parents and explain why developing skills for Informatics is so important to their children's future.

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Although boys and girls have the same skills and abilities in the use and learning of technologies, girls underestimate their competencies (i.e., they tend to have low self-esteem compared to boys) in this regard due to pressure and gender stereotypes, which skew their professional expectations. It is essential to get girls to have sufficient self-confidence and interest in technology from an early age when they are still in school. This part of the booklet will focus on the best practices and recommended actions for higher education institutions to recruit and encourage female students to study Informatics.

Best practices and Recommended actions for Universities, Research Centres and Educational Institutions:

- Informatics is an interdisciplinary discipline that increasingly plays a role in other fields such as humanities, medicine, social services, art, etc. It is important to transmit this reality in all promotional events of Informatics-related degrees so that young women can see that they can contribute, via computing, in those areas that are of interest to them and that motivate them the most (Stevenson 2020; Seibel and Veilleux 2019; Vainionpää, Iivari, et al. 2020).
- Universities should encourage their female staff to have good visibility and communication with female students to see the possibility of ordering two-subject degree programmes to integrate computing with art or another non-computing subject. An example is education and Informatics (Cronhjort et al. 2020).
- There are groups of female teachers, researchers, Ph.D. students, etc., in computing that do an excellent job and have promoted the area despite being a minority. It is important to convey that all women in the computing field of a given institution are brought together in a way that minimises the effect of being in a minority group (Seibel and Veilleux 2019; Vainionpää, Kinnula, et al. 2020).
- In general, there is a lack of orientation of training opportunities and possible career paths in computing. Organising information sessions throughout the year is important to properly orient students about all the Informatics-related degrees they can pursue and their career opportunities (Stevenson 2020; Vainionpää, Iivari, et al. 2020). Present the career paths discussed in the literature in a way attractive to women and men.
- To promote female references in the technological field in schools, breaking stereotypes and making visible technological women. It is important to develop activities to make visible new female references in a way that is attractive and appropriate for girls (Voldase 2020; Tian 2020; Seibel and Veilleux 2019; Stevenson 2020).
- Advertisement material should not build on stereotypical pictures of Informatics (such as dark colours and coding men). Instead, use bright, friendly colours, including people, ensuring gender balance and communication (Grabarczyk et al. 2022; Tian 2020). Make sure Informatics stands at Open Days as being more interesting to women.
- Universities should use gender-balanced literature and advertise that the language used is gender-neutral or balanced. Moreover, they should encourage their staff, when writing new literature, to make it attractive to females by using more gender-balanced language.

- Universities should encourage staff to change the courses' names to make them more interesting and accessible to women (Harvey 2012). For instance, University of California, Berkeley called an introductory programming module "The Beauty and Joy of Computing" with astonishing results - many more women took it than when it was called "Introduction to Programming".
- While women in Informatics are a minority group offering scholarships to female applicants could be considered. A good example of this could be mentioned in the case of Kosovo, where STEM scholarships are offered for first-year female students, resulting in gender-balanced classes (around 50% are female in the first year of the Computer Science programmes).

Best practices and Recommended actions for Schools:

- It is essential that Informatics is part of the school curriculum and teachers have the appropriate level to teach it. When the teacher does not know the subject sufficiently well, students perceive greater difficulty and lack of confidence, producing the opposite effect to the desired one, i.e. disinterest.
- The course should be designed and developed inclusively, providing examples and exercises that may interest all genders. The goal is for the girls in the course to feel part of the community and have a sense of belonging (Seibel and Veilleux 2019).
- The most relevant aspects to consider during the development of the course in the classroom so that female students do not feel intimidated are the following:
  - No male-centric paraphernalia in the classroom (Stevenson 2020; Tian 2020; Vainionpää, Iivari, et al. 2020).
  - Control those "know-it-all" students who create a toxic environment (Seibel and Veilleux 2019).
  - Avoid unhelpful instructors who make female students feel that computers are not for girls (Seibel and Veilleux 2019).
  - Help female students feel self-confident (Seibel and Veilleux 2019).
    - Organising girls in Informatics groups

Best practices and recommendations for the Ministry of Education:

- Informatics should be considered in a separate course as part of the school curriculum, and in the development of that course, female computer scientists should be involved (Seibel and Veilleux 2019).
- The course should start from an earlier age and should be motivational more than professional, presenting successful female computer scientists and their road map.
- Girls with self-interests should be encouraged through social media campaigns and promotional activities, jointly with local NGOs supporting girls (Grabarczyk et al. 2022; Tian 2020).

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Attrition rates in the first year of study are normally higher than in any other (Takacs et al. 2022). Retention rates are strongly affected by a sense of isolation, e.g., a lack of a sense of belonging (Sax et al. 2018), and low self-efficacy (Mejias et al. 2019). When we are good at a subject we feel we deserve to belong there. When students are unsure that they are good enough, or feel at fault when they do not understand, this can act as a barrier, reducing their chances of ever 'belonging'. When students cannot identify with their peers or instructors and find it hard to mix with them, it can increase their feelings of isolation. If they feel 'left behind' when they cannot grasp concepts that appear to be easily understood by others, without encouragement from peers, mentors, and instructors, it may reinforce their feelings that they are not 'good enough' or 'clever enough'. In this section, we make several recommendations to create opportunities to show everybody that they belong and deserve to belong in Informatics while providing mechanisms to support those who need encouragement. Regarding initiatives, parents of students who progress to university directly from school are often the neglected group even though it is well known that they have an even earlier influence on their children (Zauchner et al. 2021).

Best practices and Recommended actions for Universities, Research Centres and Educational Institutions:

- **Role Models**
  - Make female role models prominent, visible, and available to female students from early in the students' first-cycle degree education.
  - Encourage outreach from women working in the IT industry as role models - invite female guest speakers from industry/academia to share their honest experiences as undergraduates and to talk about their achievements (Convertino 2020; Seibel and Veilleux 2019; Stevenson 2020).
  - Increase the visibility of female peers (i.e., to other female students in the same cohort) by placing female students together in the same lab/practical group in those cases where first-year students cannot all take the same lab/practical session together due to limited resources (e.g., there is less than a 1-to-1 ratio of enrolled students to computers in a lab) (Convertino 2020; Lyon and Green 2021; Seibel and Veilleux 2019; Tian 2020).
- **Mentoring**
  - Provide mentoring support to female students in the early stages of first-cycle degree programmes. Female mentors are preferred, as evidence points to a greater sense of belonging when mentees can identify with their mentors (Lyon and Green 2021; Pantic 2020; Stevenson 2020; Voldase 2020).
  - Encourage and support female mentors from amongst the 2nd/3rd/final year student cohort in first cycle degree programmes and postgraduate programmes. Evidence also shows that self-efficacy and self-confidence increase when a female student is asked to mentor another female student (Ghio et al. 2020; Pantic 2020; Seibel and Veilleux 2019).

- Recognise mentorship as a valued voluntary activity on supplementary degree transcripts. This increases opportunities to recruit mentors from among the student population as they will be able to demonstrate a tangible, much sought-after skill to potential employers (Mondisa, Packard, and Montgomery 2021; Vrieler, Nylén, and Cajander 2020)
- Provide opportunities for work placement or internship during the degree programme (Lyon and Green 2021; Pantic 2020; Smith et al. 2020).

- **Feedback and Guidance**
  - Make it easier for women to ask/answer questions in mixed-gender mixed-ability lab/class environments (Convertino 2020; Kreth et al. 2019; Seibel and Veilleux 2019). This can be achieved by visiting each student and soliciting questions that will not be overheard. In a lecture room environment, consider allowing anonymous question-asking and answering through online services. Always point out that the questions are good or that many people have those questions, and encourage asking questions.
  - Increase opportunities for students to demonstrate they do know the material and that they are capable, through positive feedback in an environment that promotes and encourages student participation, by providing regular feedback on work/assignments during the academic term/semester/year (Nguyen and Lewis 2020; Seibel and Veilleux 2019).

- **Groups, labs, and extracurricular activities**
  - Create small-group activities/extra-classes (e.g., lab exercises, assignments, etc.) and support all-female groups (Nguyen and Lewis 2020). First-year programming exercises and assignments should be contextualised with real-world examples where possible. This will help students understand why the techniques matter (Convertino 2020).
  - Actively promote inclusive extracurricular activities in safe spaces designed to encourage women to participate (Convertino 2020; Pantic 2020).

- **Additional support**
  - Recognise, allow for, and support, students who are also primary carers.
  - For students who progress to university directly from school, parents may play an important role in encouraging them not to give up on their studies. Faculties should investigate ways to inform parents and others interested in motivating and supporting female first-year students about the deficit of female students in Informatics and the importance of gender balance in Informatics. For example, making this document available to female students with suggestions that they share it with their parents or their support network can help inform them of the difficulties they could face. Faculties should also explain what supports are provided to mitigate these difficulties.

- **Know the Data**
  - When a student decides not to pursue studies in Informatics, consider interviewing them or conducting an exit survey to discover the underlying reasons. Institutions may be able to use the data to make better decisions regarding support mechanisms.

* Create questionnaires also for the first-year female students to better understand the difficulties they face. This can also be linked to different cultures and how they perceive things to a certain degree.

Case - School of Computer Science, TU Dublin, Ireland

Since 2012, TU Dublin has introduced several retention strategies to support their undergraduate Computer Science degree programmes. The strategies include ensuring that no lab has only one female student; lab assistants solicit questions from students one-on-one; the School supports the creation of a society for female technology students; and actively involves female mentors from industry (McKeever and Deirdre Lillis 2021). The School of Computer Science has improved their overall first-year student progression rate from an average of 45% per year (2004-2008) to an average of 89% (2012-2017), and the progression rate of female students is slightly higher than male students. Coupled with an improved recruitment strategy, in 2020 TU Dublin female students made up 30% of the intake across three computing degree programmes (Deirde Lillis 2020).

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Conclusion

Gender-balance in Informatics, academia, and industry, cannot be achieved without increasing the number of women graduating in Informatics from university. Likewise, gender balance in Informatics programmes at university cannot be achieved without ensuring that girls in primary and secondary school have the opportunity to learn Informatics. Families and educators play a significant role as enablers, and in this booklet, we have brought together representative examples of how to attract girls to Informatics and keep them engaged and succeeding through to the end of the first year of a first-cycle degree programme. As a strategy to arouse interest in girls' early years and to spark their curiosity, we have also offered specifics of elective primary school practices. The examples offered are not exhaustive but we hope they will serve as a starting point for readers' reflections and discussions. The last two sections of the booklet, which deal with attracting female students to and helping them succeed in post-secondary education in Informatics, maybe the most directly applicable to the university departments in their recruiting efforts. However, these sections would not be as effective without the early planning activities aimed at children who are still in the initial stages of their educational careers. So, in our opinion, a concerted effort, including families and educators of all orders, is required.

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