ANNA Tool: A Way to Connect Future and Past Students in STEM

Original
ANNA Tool: A Way to Connect Future and Past Students in STEM / Ballatore, M. G.; De Borger, J.; Misiewicz, J.; Tabacco, A.. - In: IEEE-RITA. - ISSN 1932-8540. - 15:4(2020), pp. 344-351. [10.1109/RITA.2020.3033231]

Availability:
This version is available at: 11583/2869491 since: 2021-02-01T17:30:46Z

Publisher:
Education Society of IEEE (Spanish Chapter)

Published
DOI:10.1109/RITA.2020.3033231

(Article begins on next page)

ANNA Tool: a way to connect future and past students in STEM

Maria Giulia Ballatore, Jelle De Borger, Julia Misiewicz, and Anita Tabacco

***Abstract*— The "Increasing Gender Diversity in STEM" project involved six different partner universities around Europe. The scope of the project was to investigate the gender difference in self-perception of students in relation to their career choice. This was done through a web-based app, ANNA tool, that allows high school students to match their own personality, views, and expectations to those of engineering students and professional engineers. In the meantime, the data collection gave the opportunity to take a look at how students perceive their university and undergraduate program. This pilot application is then been further studied in order to analyse its scalability in other countries with a broader STEM content.**

***Index Terms*— STEM, gender balance, profiling tool, self-perception**

I. Introduction

MANY studies and initiatives describe changes in terms of increasing numbers of students (or decreasing in a few cases) and changes in gender representation in the STEM area of higher education. It has been investigated which factors promote a diverse group of students to apply for STEM at higher education. To increase equality in STEM education, many different approaches need to be implemented and the work needs to be done at different levels and to different target groups. For example, one of the most important factors is the role of peer and family in order to get girls to consider engineering as a field of study [1].

However, to make a change in gender diversity among the entire sector (students, graduates, engineers) also means working in different ways among different stakeholders in order to create a cultural shift. To increase gender equality means both making potential students feel that STEM education is something for them as well as making the education and the future career open and inclusive for all types of people and all types of scientific sectors [2].

A previous research project has shown that self-confidence and perception (of self in the role of engineer/technologist) are issues for high school girls [3].

A recent finalized EU funded Erasmus+ initiative project, INGDIVS project, aimed to increase the awareness of what it means to be an engineer and to address some of the stereotypes that are associated with studying a technological field. In particular, it has enabled a broad mass of young people to get a clearer picture of what an engineer does and address the concerns and questions that the youths have for engineering studies. An interactive web-based tool has been developed in order to work with young people and to give them the opportunity to be able to identify themselves as an engineer in the future. The tool assists high school students in searching for profiles similar to them in an anonymized database of profiles of current and past university students in engineering and technology. These profiles contain information about the motivations and concerns of current and past students when they chose to enter university - to provide some reassurance to future users of the tool that other people have shared similar concerns.

The project has involved the following universities: Karlsruhe Institute of Technology (Germany), KTH Royal institute of technology (Sweden), Politecnico di Torino (Italy), KU Leuven (Belgium), Trinity College Dublin (Ireland) and Técnico Lisboa (Portugal) and the following school partners: Vallauri (Italy), Our Lady's Schools (Ireland) and Heilig-Hartinstituut Heverlee (Belgium).

The findings of this project will be one of the starting points for another EU funded Capacity Building project, Engaging women into stem (W-STEM), started in January 2019, which is involving 16 Universities in 10 South American and European countries [4]. In order to make this possible, the scalability of the INGDIVS experience is been analysed.

This paper highlights the main outputs of the INGDIVS project as it was presented at the TEEM 2019 Conference [5] adding the more recent scalability studies related to the new Capacity Building project.

II. CONTEXT

The 17 UN Sustainable Development Goals were agreed on in 2015 by the leaders of the world. The aim is to make a better world in 2030. Gender equality is one of the focus areas and is an important aspect in the effort to create a sustainable world. Because sustainable development requires more science, it also requires more scientists. The world cannot afford to keep women out of science. "Gender bias is undermining our social fabric and devalues all of us. It is not just a human rights issue;

M.G. Ballatore is with the Dept. of Mathematical Sciences 'G.L. Lagrange', Politecnico di Torino, Italy (e-mail: maria.ballatore@polito.it).

J. De Borger is with the Faculty of Engineering Science, KU Leuven, Belgium (e-mail: jelle.deborger@kuleuven.be).

J. Misiewicz is with the Zentrum für Information und Beratung, Karlsruhe Institute of Technology, Germany (e-mail: julia.misiewicz@kit.edu).

A. Tabacco is with the Dept. of Mathematical Sciences 'G.L. Lagrange', Politecnico di Torino, Italy (e-mail: anita.tabacco@polito.it).

it is a tremendous waste of the world's human potential. By denying women equal rights, we deny half the population a chance to live life at its fullest. Political, economic and social equality for women will benefit all the world's citizens. Together we can eradicate prejudice and work for equal rights and respect for all." – Goal 5 [6].

Although efforts have been made in recent years to bring more women into scientific education and careers, women and girls are still excluded from participation in science. With the STEM and Gender Advancement (SAGA) project that was launched in 2015, UNESCO has set itself the goal of investigating the multiple causes of this condition more closely and providing governments and politicians with tools to improve the situation [7].

The SAGA project addresses seven goals that aim to capture all aspects of gender equality in STEM (Fig. 1).

SAGA aims to analyse which strategies affect gender balance in STEM, to develop new and better indicators, to provide tools for evidence-based policymaking, to build capacity in Member States to collect data on gender diversity in STEM, and to provide methodological documents on gender mainstreaming. In the first phase of the project new methods and tools for the implementation, monitoring and evaluation of gender equality in Science-Technics-Industries (STI) have been developed. In the second phase of the project, these instruments were tested in countries around the world. Over 300 policy makers were trained in using the SAGA mythology and it has been downloaded over 10000 times.

As a sub goal, the importance of giving women access to technology is highlighted. Gender balance and gender diversity are key to the world tomorrow. The argument that gender diversity in STEM is an essential question for a sustainable world tomorrow is easy to make. Gender balance in technical education is a topical and important issue also in perspectives beyond the equality area. It has been shown that research results are more diverse and socially relevant as women bring their own perspectives, approaches and questions to research and development.

Empowerment of girls through education in the EU has been recently addressed by the European Parliament which pointed out that while women represent the majority (54%) of higher education graduates in the EU, their employment rate and promotion trajectories do not reflect their full potential [8].

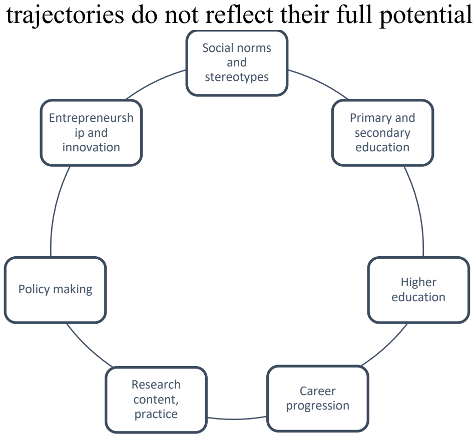

Fig. 1. The seven SAGA objectives [7].

It has been stressed that the achievement of inclusive and long-term economic growth depends on closing the gap between women's educational attainment and their position in the labour market, primarily through overcoming horizontal and vertical segregation [9]. The Parliament encourages all Member States to invest consistently in information, awareness-raising and educational campaigns and to improve the provision of career guidance for girls and boys, addressing stereotyped perceptions of gender roles, as well as gender stereotypes in vocational and professional orientation, notably in science and new technologies; recalls that this would reduce gender segregation on the labour market and strengthen the position of women whilst permitting them to benefit fully from the human capital represented by girls and women in the EU and promoting discussions of educational and career choices in schools and in the classrooms (Fig. 2 and 3).

There is a large volume of academic research which makes cogent arguments for the benefits of increased gender (and indeed other forms of) diversity in STEM [10, 11, 12, 13, 14].

Moreover, the shortage of skilled workers in the technical field is a severe problem. In contrast to the intensity and frequency of usage of information and communication technology young adults´ interest in dealing professionally with technical issues is remarkably low [16].

This becomes clear, among other things, when looking at the university student numbers. In most western countries 20% or less of graduating engineers are female, and often less than 10% of the engineering workforce. Much research has been done on the reasons for this imbalance, with a general consensus that a resolution is highly challenging, requiring multifaceted action from a very wide range of stakeholders [17].

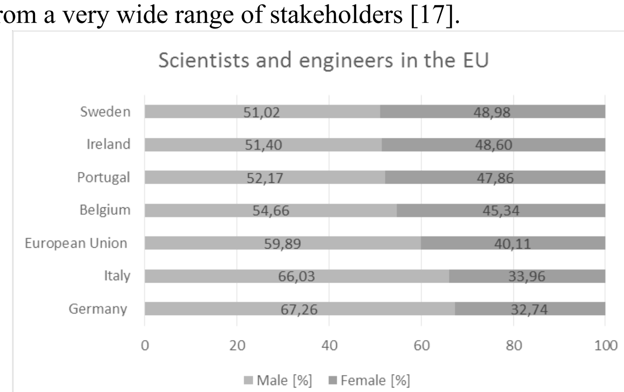

Fig. 2. Gender distribution in science and engineering in the countries taking part in the INGDIVS project [8].

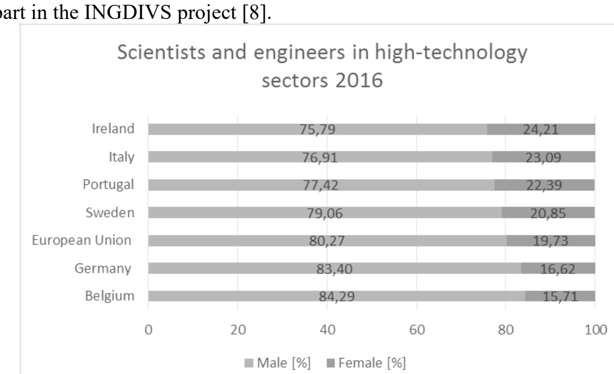

Fig. 3. Gender distribution in science and engineering in high-technology sectors in the countries taking part in the INGDIVS project [8].

The Royal Society of Edinburgh made the following key recommendations in its report 'Tapping all our Talents – 2018' [18]: Realising gender equality in STEM in Scotland calls for concerted, coherent, sustained effort across a multitude of fronts. It requires challenging deeply-entrenched societal views on gender roles in home life, workplaces and communities. It demands the transformation of perceptions of STEM through early, sustained and inspiring education and experiences. And it necessitates valuing, nurturing and celebrating the distinct contribution that women make to the workplace.

Underpinning activities at all levels and across all sectors and pathways are four themes:

- the need for leadership to drive culture change;
- the need for better data that allow real understanding and tracking of the extent of gender inequality in STEM, barriers to progress and appropriate solutions;
- a focus on behaviour change that recognises the benefits of gender equality for everyone and that renders bias and discrimination unacceptable;
- strong, sustained partnerships between educators and industry to deliver education and training that inspires all young people to engage in STEM.

A key issue identified is the difficulty that individuals have in visualizing themselves as engineers, despite generally positive disposition towards the career and the related prospects. These can be female students, professors or specialists from the field. In their everyday lives, girls are mainly in contact with their friends, parents and teachers who in many cases are not scientists. Therefore, it is often difficult for girls to get in touch with STEM role models.

Girls often have a false self-perception, that is, they tend to rate their performance in STEM worse than boys although this is often not the case. Even though they perform well in STEM, girls often do not see themselves in a science career [19]. Therefore, it is important to provide opportunities for girls to get in touch with role-models and to strengthen their self-confidence.

A previous project, named ATTRACT (Enhancing the Attractiveness of Studies in Science and Technology), aimed at examining the perception of science as a career, the recruitment strategies of students to engineering/technological studies and how the retention of students can be improved at a European level. At the end of the project, all the partners agreed that further efforts were needed to look deeper into some of the analysed aspects and bring the exploitation of the project results to a next level [3]. The ATTRACT project identified key barriers [20] and successful strategies [21] for attracting students to engineering in general but also identified specific challenges in relation to attracting female students. More concretely female students will typically be relatively well-informed about the role and career prospects, but struggle to visualize themselves in those roles. Among the reasons for this are imposter syndrome, doubts about personal capabilities, lack of role models and concerns about social inclusion in a male-dominated environment.

III. Research questions

To formulate the research questions, the ATTRACT project outputs were considered looking in particular at the gender difference highlighted. The new research hypotheses then become:

- female students are typically relatively well-informed about the engineer role and career prospects;
- female students struggle to visualize themselves in STEM roles;
- female students are more likely to have imposter syndrome, doubts about personal capabilities, lack of role models and concerns about social inclusion in a male-dominated environment.

Considering the INGDIVS objectives, the project, through the vision of real engineering experiences, wants to contribute to increasing the number of graduates attracting a broader cross-section of society into higher education.

Then, the primary research questions can be formulated as:

- Is there a gender difference in self-perception between male and female?
- What is the scalability of the instruments developed by the INGDIVS project in order to address the self-perception dissimilarity?

This involves secondary research questions as well, that is:

- How do current students and graduates perceive the STEM university environment?
- How can these data be used in order to help students to make a more informed choice by broadening their understanding about engineering as a career and by letting high school students meet and reflect over their fears and prejudices?

IV. Methodology

INGDIVS is a 34-month project with the aim to develop a filtering tool using multiple dimensions for prospective students (i.e. at the high school level) to be used in order to get a broader view of engineering.

This has been done through the creation of a multidimensional profiling tool that allows potential students to 'match' themselves to existing students and successful graduates - giving female students, in particular, the confidence to bridge the self-assured gap between understanding the career area and visualising themselves within it. The work of the international group led to "Anna", a tool for high school students.

The project has been organized in five work packages: (i) Definition of key inputs for profiling tool, (ii) Development of resources and data gathering, (iii) Pilot testing, (iv) final development of the tool, and (v) dissemination and implementation.

The output of the first work package was a definition of the kind of question that should be included in the filtering tool. Furthermore, gender-specific issues and strategies around the question styles and data collection methods were defined. Cultural, social and educational nuances relevant to each of the participants locations were accounted.

After the brainstorming activities (Fig. 4), all partners agreed that the main idea of the tool was to support high school students, rather than to test or select them. Furthermore, a strategic decision was made to focus the content in the tool on apprehension and to respond to possible stereotypes instead of focus on psychometric data such as different thinking and personality styles and aptitude testing.

Because the main point is to provide an opportunity for high school students to explore the feelings and sorrows of current engineers and engineering students, it was decided to build the Anna tool with short profiles from alumni and current bachelor students. To this end, a questionnaire was constructed to collect the data and create a database for the Anna tool. This survey contains four sections, with the latter two being optional:

a. Basic details, including course of study, age, hobbies or interests, features they like about the university etc.
b. Self-perception, at the time of entry to the university. Respondents to the survey are asked a number of questions designed to reflect the issues identified in the ATTRACT project. There are two principal groups within this section – experiences or influences (e.g. influence of friends, support of parents) prior to selection of an engineering programme, and prior perceptions of what the experience of studying engineering would be like (e.g. perception of the gender balance, comparative level of hands-on experience). For this latter group, the questions are in two parts – the perception, and a follow-up as to whether this perception was in fact accurate.
c. Thinking styles – these are loosely based on the five-factor model.
d. Personality types - these are loosely based on Jungian personality types. It should be noted that they are not in any way intended as a diagnostic tool – but for use as a matching tool.

To make the tool student-friendly it was decided that each country had it translated in its own language. Then, for each engineer, based on his/her answers, a short paragraph is assembled (Fig. 5), which can be modified manually by the survey respondent if desired. At the end of the above processes, the data collection has begun. As the data collection started, each partner needed to sanitize the answers in order to ensure that publicly visible information met appropriate standards.

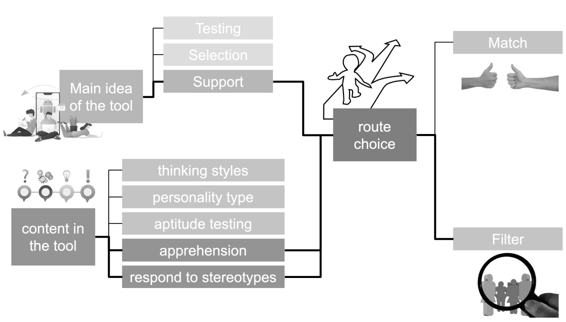

Fig. 4. Contents structure of strategic choices made during development with the agreed elements in dark colour.

In the meantime, the filtering tool, as well as the visualization of data, was developed to allow high school students to map their views and ideas about an engineering career to current and graduate students.

The prototype of the tool was tested on groups of high school students in order to get valuable knowledge about both their attitude toward the tool and the interface and visualization of the tool.

Thanks to the student feedback, some modifications of the interface were made as well as more profiles added to the database. The final tool has then been disseminated in each partner university through a local training event and at a European level through a training event in Lisbon in April 2019 and a final event in Stockholm in June 2019.

The Anna tool database population contains 1454 records, approximately equally distributed between female and male responses. The average age of the respondent is 26 years old for female and 27 years old for male.

Anna tool is country-dependent, that means that the matches are organized on the basis of the selected partner university. More precisely, this implies the use of the language of the specific country and the database related to that partner. For example, if a high-school student coming from a non-partner country is interested in applying to a partner university like KIT, he/she can choose the KIT database, answer to the profiling questions in German and discover if he/she has any similarity with KIT current students or alumni.

Due to privacy and security reasons, a real link between high-school students and engineers is not allowed. Instead, a virtual connection is established thanks to the short paragraph (Fig. 5) and the additional information reported in the top of the postcard (hobby, major, …).

V. Findings

The main output of the INGDIVS project is the 'Anna' tool. This can best be described as a search engine for connecting potentially interested students at the high school level with anonymised profiles of real engineers or engineering students. The tool has been designed to be simple and intuitive to use and to be stylistically appealing to the target demographic – using focus groups during the pilot testing phase.

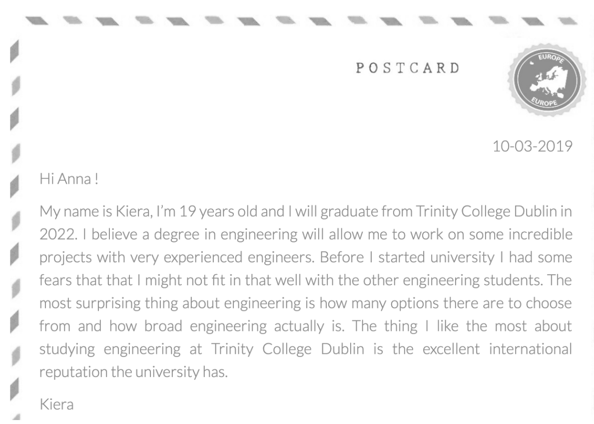

Fig. 5 Anna tool profile example

In order to make the Anna tool as user-friendly as possible, an early decision in the project was to have the tool available in all corresponding language as inbound partners. By choosing the language, the user can also choose the university from which the feedback from past students will come.

When entering the tool, the user initially can choose between if he/she wants to search in the entire database or if he/she just wants to be filtered among graduates or present students.

Depending on the users' answers in the filtering modules, five engineers or engineering student profiles are visible. The user gets information about people from the database: about their field of study, age, interest and university, as well as some information about the personal interests and ideas about an engineering career and opinion about the university they attended.

The data that powers the tool comes from surveys of current engineering students and graduates from engineering programmes in the partner universities.

When using the Anna tool, users can select to match using self-perception only or by including thinking types and/or personality types. For each section, matching is effected by moving sliders in response to the questions asked in the surveys. For example, users can position the slider on a scale from 'Strongly disagree' to 'Strongly agree' in response to the question 'My friends' opinion would influence what I study at university'. The mechanism is very similar (and purposely designed to be so) to popular online tools such as hotel booking websites. The user is encouraged to 'play' with the sliders and to move between the results tab and the search criteria tab. The search results tab automatically updates with the closest matches.

A key assumption in the INGDIVS project has been that there are certain differences in what can be broadly characterised as self-perception, between male and female students. A sample of engineering students and graduates in the 6 project countries were asked a total of 17 questions. There were 1454 valid and complete responses, of whom 22 declined to identify their gender (Fig. 6). 658 male and 774 female responses (1432 total) were used for the following analysis. The 17 questions consisted of 5 questions regarding prior influences/expectations and 6 regarding prior expectations. The latter six each had a follow- up (Likert, -2 to +2) question 'In reality I found this was not the case'.

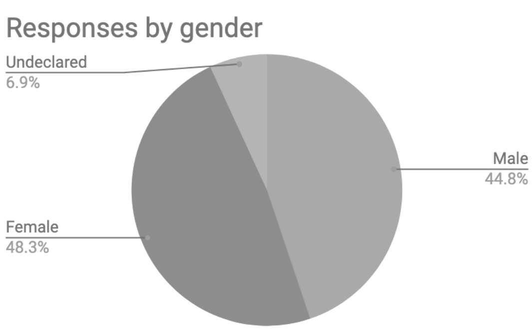

Fig. 6 Gender distribution in Anna tool database

The questions can be found on www.projectanna.eu/Anna/main.php?lan=en under the 'Self-perception' heading.

A Welch test was used to evaluate the statistical significance of the differences in mean response between male and female responses. The results below show which questions had statistically significant differences at the 95% significance level or better.

In the meantime, the information used for the creation of the profile gives us a picture of the self-perception of alumni and current students. For example, if one considers the statement "I believe that a degree in engineering will allow me to …", by looking at the distribution of the answers each partner can have the feeling on how students perceive their degree (Fig. 7). For the majority of female current students, the degree seems to allow them to meet a lot of really smart and interesting people, while for female alumni the project in which they worked have a greater weight. In general, 11,6% of the interviewed didn't find themselves in any of the given answers and complete the sentence with a more personal feeling.

Similar analysis has been performed for each of the statement used in the profile and the main considerations are:

- Very few people (5%) have the perception of not enough work in teams or with other people as the biggest concern before starting the engineering degree
- Almost the majority of people (46%) thought that the course was too difficult for them before starting university
- 65% of alumni and current students were surprised by how many options there are to choose from and how broad engineering actually is
- 34% appreciate the excellent international reputation of the partner university and 30% like most the other students they met.

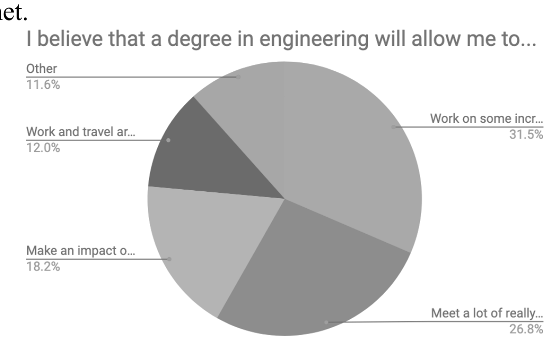

Fig. 7 Pie-chart of the statement "I believe that a degree in engineering will allow me to..."

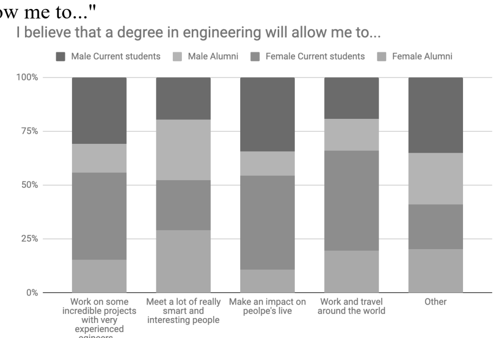

Fig. 8 Distribution on the statement "I believe that a degree in engineering will allow me to..." based on gender and students status

TABLE I
Questions with the related p-value and interpretation

Question	**p-value**	**Interpretation (including average responses in parentheses)**
1. My friends' opinion influenced what I studied at university	0,00035	Female students (-1,06) less likely to be influenced by what friends thought than male students (-0,87)
2. My parents' encouragement was one of the reasons I studied engineering	0,00036	Females (0,18) more influenced by parental encouragement than males (-0,05)
3. I thought most of my classmates would be male		
- In reality I found that this was not the case	0,00000054	Females (-0,46) more positively surprised by percentage of female classmates than males (-0,82)
4. I thought that most people choosing engineering would have lots of hands-on experience	0,000045	Females (0,30) expect more classmates to have a lot of hands-on experience than males (0,04)
5. A worry I had about studying engineering was that I wasn't excellent at Maths or Science	0,0043	Females (-0,56) more likely to have doubts about relative mathematical ability than males (-0,76)
6. I thought an engineering programme would be very difficult	0,00069	Females (1,27) more likely to perceive engineering as difficult than males (1,13)

Fig. 8 shows very interesting results, although it is limited to the vision of the 1454 respondents. Thus, one identified weakness within the tool is that it only refers to engineers and engineering students in the database. So, the tool just offers an insight into engineering. The tool enables the user to see different perspectives of engineering and who engineers are. It does not give the user any advice if engineering studies suit him/her or not. The tool should be used to reflect over possible interest and a possible future career. If the user needs advice or support, it is recommended that he/she talk to a student counsellor or equivalent.

On the other hand, one big advantage of the tool is that it is free to use, and no login is required. By the design of the tool, we have tried to make it suitable for both girls and boys. The tool offers an opportunity not only in supporting gender equality in engineering education but also in non-academic topics. The interactive design makes it possible for the users to use the tool in different ways: just giving the answers, or seeing what different answers give as a result.

In order to scale this pilot project to other reality, two major points must be analyzed and discussed: the data collection design and the language used in the survey and in the profiling system.

Due to the fact that career decision is based on self-perception, the data collection need to take into consideration the different cultural aspects the high-school student and the institution may have. As a matter of fact, the cultural heritage affects the way people see the world. During the focus group with high-school students, each country highlighted different aspects of the tool. For example, the tool was considered, to:

- challenge you to think about your stereotypes and perceptions mostly in Sweden and Belgium;
- make a career in STEM to be more relatable when one can see people experiences in Italy, Spain and Germany;
- makes you think of engineering as a career track which is not highlighted often in school in Ireland.

Moreover, this different cultural approach may also affect the type of questions one should ask in order to improve the accuracy of the match. The scalability can easily also involve the entire STEM sector by collecting data from all the different scientific fields and not just engineering students and alumni.

Another important aspect of the data collection that needs to be considered for the scalability of the project is the sanitization of the dataset. In the INGDIVS pilot each partner was responsible for the cleaning of their own data. Then, while scaling the data collection one needs to clearly define the responsible of the sanitization. This is a crucial stage because some answers of current students and alumni may contain improper things, like referring directly to third person.

In the meantime, the language of the tool needs to be country-dependent because high-school students may not be familiar with English, especially when considering future career decisions. On the other hand, this may impede the use of the tool by foreign students. As it is, the match requires a basic knowledge of the language spoken in the country where a specific campus is based. In any case, if a new country wants to use this tool a translation of both the survey and the tool need to be implemented. In addition, a sufficient number of records in that specific country is needed to be collected so that the match can be properly performed.

VI. Conclusions

The findings from the statistical analysis of the survey data broadly support the hypothesis that there are significant differences between how male and female students at the high school level think about engineering. The results give quantitative evidence that can be used to design appropriate communication and intervention strategies, specifically indicating that parental encouragement is more important for female students and that fears about ability, competence, experience and gender ratios are somewhat misplaced and might be addressed through role-model communication and information campaigns.

Thanks to the Anna tool database all partners can know how some students and graduates perceive the STEM university environment. In general, the variety of engineering career options is a (positive) surprise, as well as an appreciation of the international reputation of the university and the fellow students they met during the study period. The perception of the engineering degree as something too difficult is a common feeling. These results create for the project partners a deep knowledge of the characteristics associated with an engineering degree and on how to effectively promote engineering studies to female students.

In the meantime, it directly helps potential students by mapping their own characteristics to those who are engaged in engineering studies or careers. For high school students, this tool will help to give them the confidence to undertake studies in engineering/technology as they will be able to directly compare themselves to students who are pursuing, or have already, successfully pursued courses in these areas. In particular for female students who, as noted in the literature, tend to underestimate their own ability relative to that of their peers, a quantitative and qualitative referencing of their own abilities will help to give the confidence required.

Anna is an easy way to virtually connect with role-models and career opportunities in engineering. Being an online-tool, Anna is a medium preferred by the target group. It does not take much time but gives valuable information and inspiration. Anna will spark girl’s interest in engineering and show them ways to get more information about it. The latter is very important as an online tool cannot replace personal counselling. Anna will encourage girls to contact student counsellors at schools or universities and use the orientation programs offered by the universities.

Finally, the Anna tool is a very low threshold way to get a first taste of studying and working in the field of STEM. By displaying very different people who work in engineering, both girls and boys get an idea of how broad the filed actually is. They learn that there is not just one (stereo-)type of engineer but very different personalities with different backgrounds and interests. By matching their own views and personality, the girls feel a connection with the people in the database, which makes the tool more personal and authentic.

Considering the scalability aspects, Anna tool structure can be easily used by other institutions around the world. In addition to some basic technical adaptation, a translation needs to be implemented in the survey and the tool itself. Then a new data collection can start in order to populate the database. Once the records are been checked by the sanitization process, Anna will be ready to use.

INGDIVS project was possible thanks to the learning outcome of the ATTRACT experience. Now, thanks to the deeper analysis on self-perception and tool development the W-STEM project will spread the new knowledge achieved in non-EU countries.

In the meantime, additional feature will be added to the profiling tool for South American countries in order to favour a better interaction between future and past students. In particular, a portable app will be developed in order to provide complementary materials: video-recorder interviewed of local role-model, social-media interaction and press materials [4].

Acknowledgment

The project is a collaboration of numerous individuals in each of the universities and schools who participated in the work. We wish to thank them for their contribution and assistance.

We do also want to thank all current students and alumni who have contributed to building up the database in Anna tool as well as the high school students who gave us invaluable feedback in the development of the tool.

Funding

The INGDIVS project has been co-funded by the European Union under the 2015 Erasmus+ Strategic Partnerships call for proposals (2016-1-SE01-KA203-022114).

The W-STEM project is co-funded by the European Union under the 2017 Erasmus+ Capacity-building in Higher Education Call for proposals (EAC/A05/2017).

The funding body had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

References

[1] S. Barnard, T. Hassan, B. Bagilhole e A. Dainty, «‘They're not girly girls’: an exploration of quantitative and qualitative data on engineering and gender in higher education,» *European Journal of Engineering Education,* vol. 37, n. 2, pp. 193-204, 2012.

[2] UNESCO, *STEM and Gender Advancement (SAGA),* https://en.unesco.org/saga.

[3] U. Rintala, A. K. Kairamo , S. Andersson, M. Strandås, K. Kelly, I. Gonçalves, A. Lucas e A. Tabacco, «Knowing our students - Different approaches to student retention experiences of the ATTRACT project,» in *Proceedings of the 40th SEFI Annual Conference 2012*, Thessaloniki, 2012.

[4] W-STEM Project, «ENGAGING WOMEN INTO STEM: Building the future of Latin America,» 2019. [Online]. Available: https://wstemproject.eu/.

[5] M. Ballatore, L. Barman, . J. De Borger, J. Ehlermann, R. Fryers, J. Misiewicz, I. Naimi-Akbar e A. Tabacco, «Increasing gender diversity in STEM A tool for raising awareness of the engineering profession,» in *Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2019)*, Leòn, Spain, to be appear in.

[6] U. Nations, *Goal 5: Achieve gender equality and empower all women and girls,* https://www.un.org/sustainabledevelopment/gender-equality/.

[7] UNESCO, «Telling SAGA: Improving Measurement and Policies for Gender Equality in Science,» in *Technology and Innovation, SAGA Working Paper 5*, Paris, 2018.

[8] Eurostat, *Tertiary education statistics,* https://ec.europa.eu/eurostat/statistics-explained/index.php/Tertiary_education_statistics#Participation_by_level , 2018.

[9] European Union, «Report on equality between women and men in the EU 2018,» Publications office of the European Union, Luxembourg, 2018.

[10] M. W. Nielsen, S. Alegria, L. Börje, H. Etzkowitz, H. Falk-Krzesinski, A. Joshi, E. Leahey, L. Smith-Doerr, A. W. Woolley e L. Schiebinger, «Gender diversity leads to better science,» in *Proceedings of the National Academy of Sciences*, 2017.

[11] A. W. Woolley, C. F. Chabris, A. Pentland, N. Hashmi e T. W. Malone, «Evidence for a collective intelligence factor in the performance of human groups,» *Science,* vol. 330, n. 6004, pp. 686-8, 2010.

[12] P. L. Curşeu, H. Pluut, S. Boroş e N. Meslec, «The magic of collective emotional intelligence in learning groups: No guys needed for the spell!,» *British Journal of Psychology,* vol. 106, p. 217–234, 2015.

[13] A. W. Woolley e T. Malone, «What makes a team smarter? More women,» *Harvard business review,* vol. 89, pp. 32-3, 2011.

[14] A. W. Woolley, C. F. Chabris, A. Pentland, N. Hashmi e T. W. Malone, «Evidence for a Collective Intelligence Factor in the Performance of Human Groups,» *Science,* vol. 330, n. 6004, pp. 686-688, 29 Oct 2010.

[15] C. Herring, «Does Diversity Pay?: Race, Gender, and the Business Case for Diversity,» *AMERICAN SOCIOLOGICAL REVIEW,* vol. 74, p. 208–224, 2009.

[16] M. Esch e J. Grosche, «Fiktionale Fernsehprogramm im Berufsfindungsprozess – Ausgewählte Ergebnisse einer bundesweiten Befragung von Jugendlichen.,» *Bundesministerium für Bildung und Foschung (BMBF),* 2011.

[17] Microsoft Study, «Why Europe's girls aren't studying STEM,» 2017.

[18] Royal Society of Edinburgh, «Tapping all our Talents 2018,» Edinburgh, 2018.

[19] E. Henriksen, J. Dillon e J. Ryder, Understanding Student Participation and Choice in Science and Technology Education, Springer, 2015.

[20] K. Kelly e C. Marshall, «Prediction of engineering student progression from entrance data,» in *29th International Manufacturing Conference*, Belfast, 2012.

[21] K. Kelly e T. Mooney, «Design thinking as an outreach activity for female students,» in *30th International Manufacturing Conference*, Dublin, 2013.