

Female students at technical universities - gender as the factor determining the choice of engineering studies

Anna Porębska, Stanisław A. Mitkowski, Andrzej M. Dąbrowski & Piotr Zegarmistrz

AGH University of Science and Technology
Kraków, Poland

ABSTRACT: Technical studies are assumed to be difficult for both male and female students. Such studies are not popular, especially among girls, and this tendency is observed all over the world. The authors of this article discuss female students' participation rate in studies at technical universities. The first part of this article shows how gender determines the decision made on the type of university education and how this has been changing in Poland over the past four years. The second part describes a competition for young would-be students who apply for admission to the AGH University of Science and Technology in Kraków, Poland. In the last part of this article, an initiative is described that was taken by a group of leading technical universities in Poland, to stimulate women's interest in technical studies. Its motto: *Girls as Engineers!* The purpose of the campaign was to acquaint women with educational opportunities and to show that female students are able to achieve good results in technical sciences.

INTRODUCTION

The year 2011 has been declared the *Year of Maria Skłodowska Curie* in Poland and France. One hundred years ago the Nobel Prize in chemistry was awarded to this famous Polish and French scientist. Maria Skłodowska Curie was the first woman to win the Nobel Prize. She was also the only woman awarded the Nobel Prize twice: in physics (together with her husband Pierre Curie and Henri Becquerel) and in chemistry, and the only person awarded the Nobel Prize in multiple sciences.

Maria Skłodowska finished her high school education in 1883 in Warsaw, the capital city of the Polish territories under Russian governance. Since women could not study at universities in Poland at that time, she decided to continue her education at the Sorbonne in Paris in 1891. She received a Bachelor degree in physics (in 1893) and mathematics (in 1894). Universities in France were open to women, but not for French women since there were no high schools for girls that could prepare them for the final examinations necessary to apply for admission to universities.

For many years subjects such as physics, biology and Latin were not taught to girls in high schools. The law allowing high school education for women was established in 1880 in France, but until 1937 the school programmes for boys and girls were different. The law allowed university education for women at Jagiellonian University in Kraków in 1897 (in Austria's part of the then partitioned Poland), four years after Maria Skłodowska Curie received her first Bachelor degree [1].

What has changed after 100 years in women's education? Everything. The programmes in schools at each level are the same for girls and boys. Women have free attendance at every type of university. In the European Union there are 49% girls and 51% boys among young people aged between 20 and 24. The ratio of male to female higher education students is 55.5% (girls) to 44.5% (boys) [2].

In Poland, this tendency is clearly visible, too. Sixty percent of all Polish students are women. However, women comprise just 34% of technical university students. The second section describes how the number of female students has changed in Polish technical universities over the past four years. In the next section, the predisposition for engineering studies is discussed, through the example of participants in the competition organised by the AGH University of Science and Technology in Kraków, Poland. In the final section, the campaign *Girls as Engineers!* is described.

FEMALE STUDENTS AT TECHNICAL UNIVERSITIES IN POLAND

The latest data from Eurostat shows that in the population of young people (YP) aged 20-29 in 2009, graduates in mathematics, sciences, technology (MST) per 1000 of YP comprised 14.3% in the EU and 14.3% in Poland [3]. Female

graduates (ISCED 5-6) in mathematics, science and technology per 1,000 of female YP were 9.4% in EU and 11.0% in Poland. Male graduates (ISCED 5-6) in mathematics, science and technology per 1,000 of male YP were 19.2% in the EU and 17.4% in Poland. Among MST students there are 30.9% girls and 70,1% boys. Thus, women are better represented in higher education in Europe generally, but clearly prefer fields other than engineering.

Women’s participation in engineering studies in Poland has been examined since 2007 by the *Perspektywy* (Frontiers) Education Foundation. The Foundation, together with the Conference of Rectors of Polish Technical Universities (KRPUT), were initiators of the education campaign *Girls as Engineers!*, which aimed to arouse women’s interest in technical studies [4].

Information on female students is shown in Figure 1, for the following public technical universities in Poland: the AGH University of Science and Technology in Kraków; Białystok University of Technology; Cracow University of Technology; Częstochowa University of Technology; Gdańsk University of Technology; Kielce University of Technology; Koszalin University of Technology; Lublin University of Technology; Opole University of Technology; Poznań University of Technology; Rzeszów University of Technology; Silesian University of Technology; Szczecin University of Technology; Technical University of Łódź; Technical University of Radom; University of Technology and Life Sciences in Bydgoszcz; Warsaw University of Technology; Wrocław University of Technology; and the Military University of Technology in Warsaw.

Universities possess different numbers of students in engineering and science faculties. Those with a bigger number of engineering faculty students have a smaller share of female students. Figure 1 shows the percentage of women as students at technical universities, and how it has changed over the past two academic years 2009-2010 and 2010-2011. The universities are ordered by decreasing percentage of female students in the 2009-2010 academic year.

Generally, an increase in the percentage of female students in 2010-2011 can be observed. The increase overall is about 2% but is greater for the Technical University of Radom and smaller for Warsaw University of Technology, where there was a reduction. The order of universities remains almost unchanged in 2010-2011, with the average percentage of female students 34%.

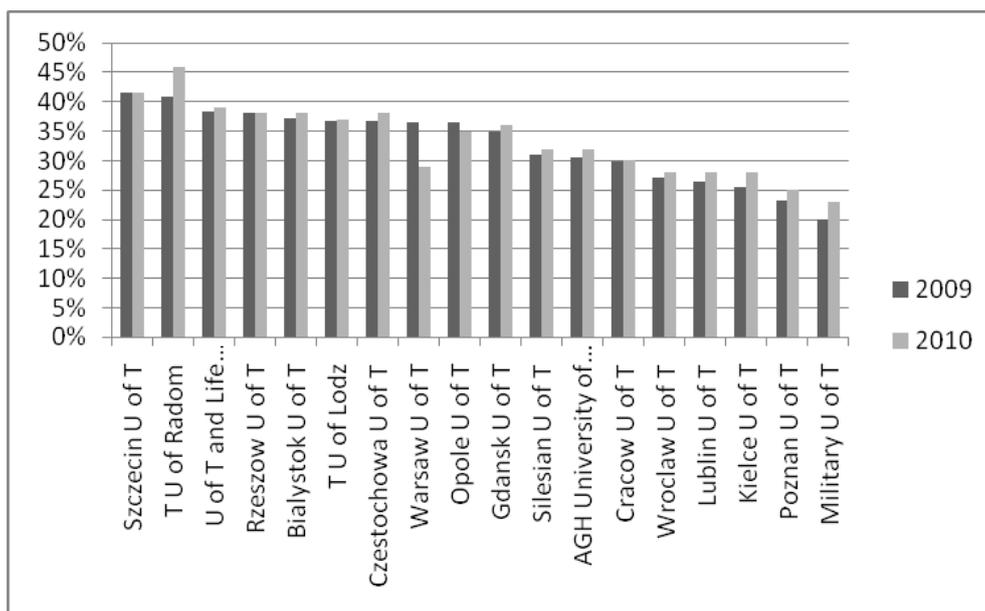


Figure 1: Percentage of female students at Polish technical universities in 2009-2010 and 2010-2011 (Source: *Perspektywy* Education Foundation 2010-2011).

The increased share of female students at technical universities is closely connected with the increasing number of female students in the first year. How it has changed can be observed in Figure 2, which shows the percentage of female students in the first year of studies at technical universities from 2007-2008 until the 2010-2011 academic year. Two universities have shown significantly greater changes than other universities in the past year, which is connected with the establishment of new faculties [4][5].

Generally, there is a tendency for an increased interest in engineering education among female students. The average percentage of women in the first and subsequent years of studies is near to 34%. This is important given demographic data, which point to decreasing numbers of young people between 20 and 24 years. Therefore, a greater percentage of high school female graduates are choosing an engineering education. Nonetheless, women remain in a minority among students of technical universities and a majority at other types of university.

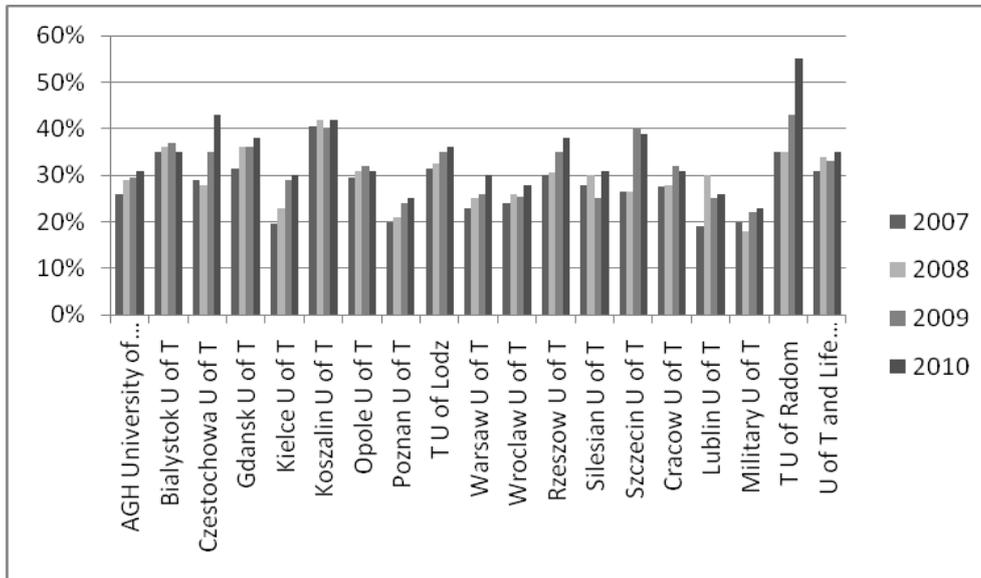


Figure 2: Percentage of women in the first year of study at technical universities for different years (Source: *Perspektywy* Education Foundation 2010-2011).

Universities possess different structures and contain different numbers of students in engineering and non-engineering faculties (such as science and management). Even though the number of female students in universities is large, the engineering faculties are less attractive to them. Figure 3 shows the proportions of female students in engineering and non-engineering faculties at various universities during the 2009-2010 and 2010-2011 academic years. The number of women in engineering faculties varies significantly. For five out of 11 universities, the percentage of women last year (2010-2011) was less than in the previous year (2009-2010).

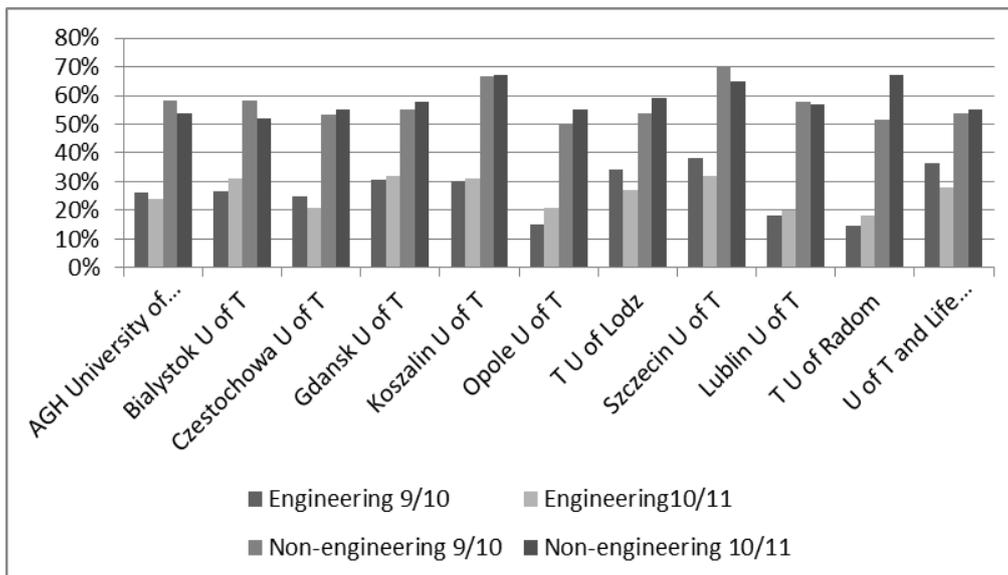


Figure 3: Percentage of women as students of engineering and non-engineering faculties in 2010-2011, compared to 2009-2010 (Source: *Perspektywy* Education Foundation 2010-2011).

Moreover, according to the *Perspektywy* Education Foundation, typical technical faculties have only a few percent female students. For example, at the Faculty of Electrical Engineering and Computer Science, Rzeszów University of Technology, women represent 2.4% of students; at the Faculty of Electrical Engineering of Silesian University of Technology, women represent 2.5% and at the Mechanical Faculty of the Technical University of Radom, only 3% [4].

However, the general trend in departments with the lowest percentage of women is for that percentage to be growing. An excellent example is the Faculty of Mechanical Engineering and Robotics, AGH University of Science and Technology in Kraków, where between the academic years 2009-2010 and 2010-2011 the participation of women starting studies increased, from 5% to 7% of the total.

Are girls less predisposed to engineering education? Why is gender a factor in determining the choice of technical studies? Some answers can be found in *Women and Information and Communication Technology* prepared for the

European Schoolnet (EUN) in 2009. The authors based their results on investigations of five European countries (including Poland). Their main conclusions are:

- Girls are roughly equal to boys in aptitude for ICT at the secondary level.
- Most girls enjoy studying ICT; however, this enjoyment does not often translate into careers.
- Female role models generally exert a strong influence on girls making decisions about further study/careers.
- These role models are not *tech-savvy*; however, most mothers surveyed are positive about ICT. Where mothers are most positive, daughters share these positive attitudes.
- Both students and role models generally believe that technology is better suited to men [6].

It seems that such statements could be extended to other fields of engineering education.

COMPETITION OF THE AGH DIAMOND INDEX

Since the academic year 2007-2008, the AGH University of Science and Technology in Kraków, Poland, has organised the *AGH Diamond Index* (Diamond Study Book). This is a competition for young people who want to study at the university [7]. The competition is carried out within four fields: mathematics, physics, chemistry and geography. After reaching 70% of the possible points, participants are qualified at the upper level. In level 1, the task for participants is to solve the maximum number of problems individually at home and return the solutions in writing to the organisers. During the next two levels, the participants under supervision undertake a test within the given subject area. Winners with the highest score in each subject can study at the AGH University of Science and Technology, in a chosen faculty.

In the 2009-2010 academic year, 1,871 participants passed to the second level of the competition. There were 1,216 participants in mathematics, 328 in physics, 114 in chemistry and 213 in geography. In the 2010-2011 academic year, 1606 participants reached the second level of the competition. There were 810 participants in mathematics, 419 in physics, 87 in chemistry and 290 in geography. Among them, women were in the minority.

The number of female and male participants in the *AGH Diamond Index* is presented in Figure 4, after the second level and Figure 5, after the third (final) level. Data refer to the two academic years 2009-2010 and 2010-2011.

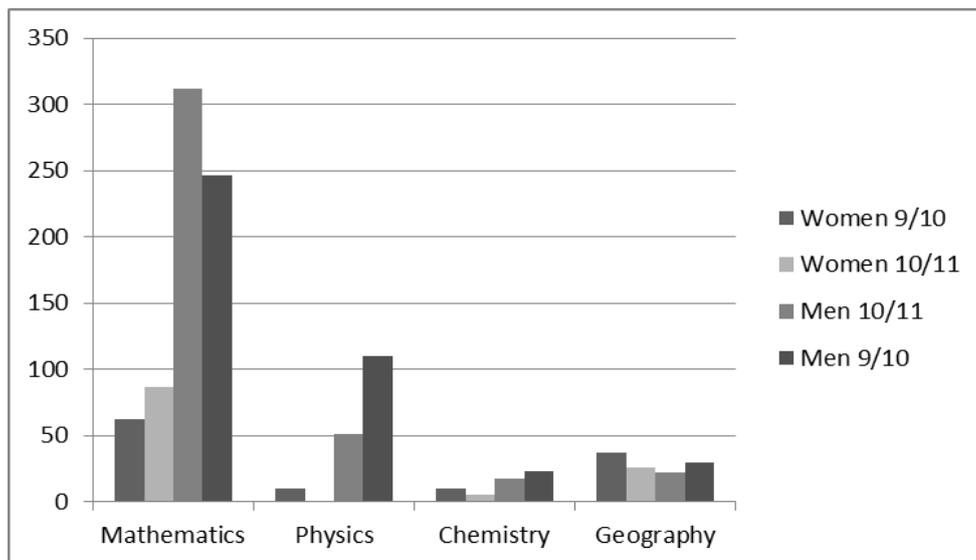


Figure 4: The number of female and male participants in the *AGH Diamond Index*, after the second level in the academic years 2009-2010 and 2010-2011.

As can be seen in Figure 4, mathematics and chemistry respectively are the most and the least popular subject in the competition. The number of female and male participants in mathematics with the highest score after the second level, increased in 2010-2011 over 2009-2010. For other disciplines, the numbers were smaller. Girls are in the majority for geography only. In physics the disproportion between girls and boys is the biggest. While in 2009-2010, ten female participants passed to the next level in this field, in the next academic year only one woman managed to do it.

As can be seen in Figure 5, the number of both female and male winners in mathematics and physics increased in 2010-2011, compared to the previous year. Similarly to 2009-2010, there were no women among the winners in physics. Only four females received the highest score in chemistry and in the previous level there had been just five females. Thus, their success is significant. In geography, the number of female and male winners was the same. The best results in 2010-2011 were in mathematics, which had many more winners than for other subjects. In this subject, the number of winners was significantly higher than in the previous year. It also indicates the better qualifications of participants.

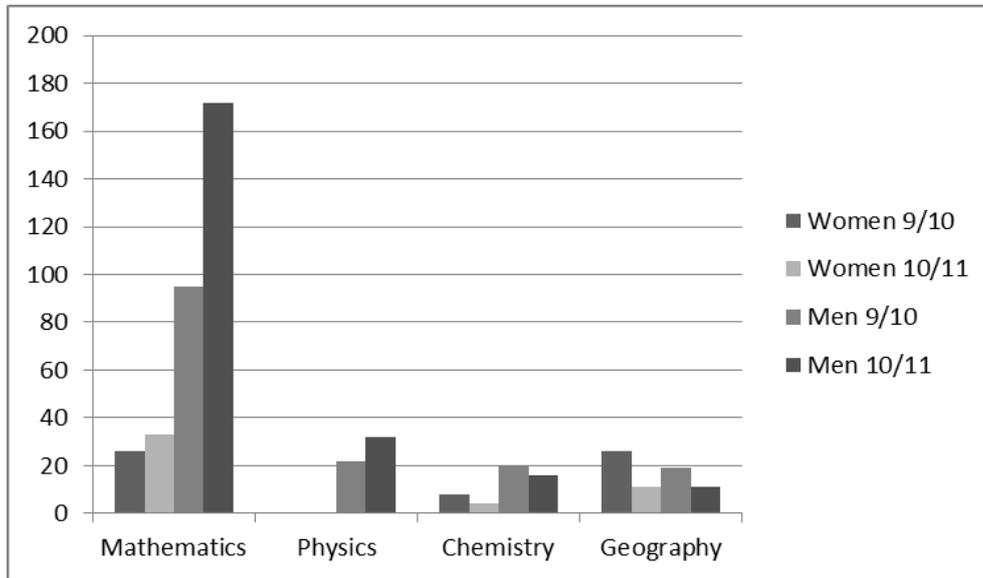


Figure 5: The number of female and male winners in the *AGH Diamond Index*, after the third level in the 2009-2010 and 2010-2011 academic years.

In Figure 6, the percentage of female participants, after the second and final level, is shown. The average proportion of male and female participants in this competition is similar to the general tendency of women's interest in engineering studies.

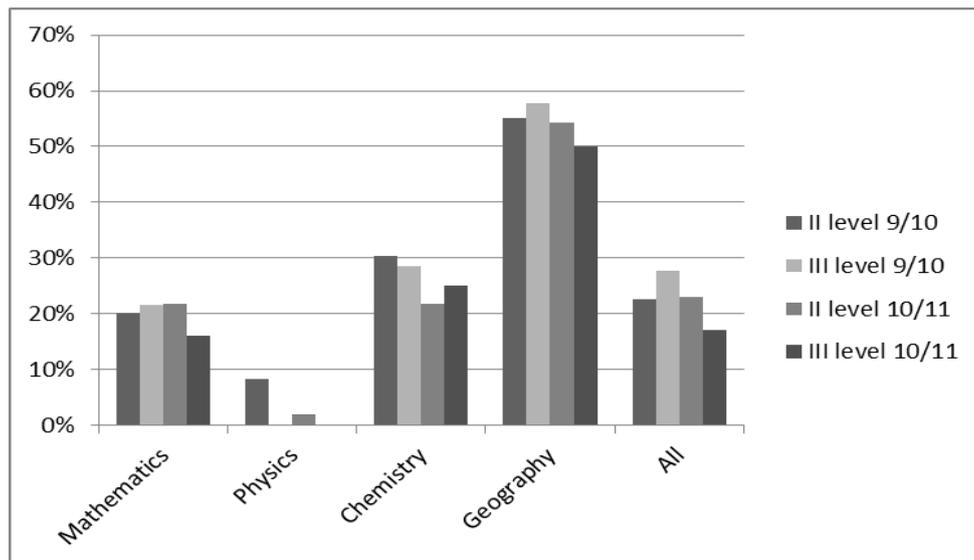


Figure 6: Percentage of women in the *AGH Diamond Index*, after the second level and after the last level in the 2009-2010 and 2010-2011 academic years.

The percentage of women among the participants who received 70% or more of the total points was even greater at the third level of the competition than on the second level in 2009-2010. This proportion significantly decreased in physics only. In 2010-2011 this is practically the same at the second level, but clearly decreases at the third level. The only exception is chemistry, where final level results were even better. In mathematics and geography, the percentage of women at different levels of the competition remains similar. On the other hand, physics seems to be very difficult for all participants and particularly for women. The average percentage of women at the third level for all fields except physics is 30%.

Graduates of high schools are more likely to choose non-engineering studies because physics and chemistry, essential at technical universities, are difficult for them. Making the teaching of both these fields more friendly would make more young people, especially girls, interested in technical subjects and encourage them to continue an education in engineering studies.

The *AGH Diamond Index* was run for the fifth time in the 2011-2012 academic year, It is too early to have information about the competitors: the first level is in progress.

THE EDUCATIONAL CAMPAIGN, *GIRLS AS ENGINEERS!*

Girls as Engineers! (Dziewczyny na politechniki!) is a campaign initiated by the *Perspektywy* Education Foundation and the Conference of Rectors of Polish Technical Universities (KRPUT). Bianka Siwińska from the *Perspektywy* Education Foundation, the author and co-ordinator of this campaign, said: *It [the campaign] plays a big role in breaking stereotypes about division between feminine and masculine faculties* [4].

This educational movement began in 2007. It is based on a similar German initiative - *Girls' Day* [8]. That is, technical enterprises, enterprises with technical departments and technical training facilities, universities and research centres are invited to organise an open day for girls. Similar campaigns are carried out in several other countries. There are, e.g. *Women into Science, Engineering and Construction* (WISE) in the United Kingdom and Ireland and *Women in Engineering* in the USA. The latter programme is so popular in the USA that every university has its own version and appropriate information about it is placed on the Internet.

Universities participating in the campaign in Poland invite all interested girls to take part in an *Open Day for Girls only*, which takes place in April. This particular *Day* in Poland was held on the same one as *Girls' Day* in Germany. During the *Day* women participated in laboratory experiments, workshops and lectures, as well as in meetings with women professors and students. Female scientists presented particular examples aimed at proving that technical studies can be interesting and inspiring for girls as well. The Open Day is a most important element of the campaigns but not the only one. Girls can search for useful information and be in contact with female engineers and students *via* the Internet [4].

Having compared the number of female students during the past four years, the *Perspektywy* Education Foundation noted that the number of women at universities that participated in the campaign, increased more than at those that did not join it. The average increase in 2010-2011 was 2%. It is higher at some universities, such as Poznań University of Technology (3.7%), Rzeszów University of Technology (3.8%), Częstochowa University of Technology (4.7%), and Kielce University of Technology (5.6%). The growth in number of female students at technical universities that did not take part in the campaign was just 0.7%.

CONCLUSIONS

Technical universities are not as popular as other types of university, particularly among women. Engineering and technology education is considered difficult by both male and female students. Many women perceive an engineering career as better suited to men. A smaller percentage of girls, as compared to boys, are interested in subjects necessary for a technical education, such as those in which Maria Skłodowska Curie received Nobel Prizes. Nevertheless, results for women in the competition *AGH Diamond Index*, are as good as the boys' results and show that women are not less successful in these technical subjects.

Women's participation in technical universities in Poland is growing systematically (from 30.5% in 2008-2009 to 34% in 2010-2011 of total student numbers). The educational campaigns aimed at arousing female interest in technical studies, such as the one organised in Poland by the *Perspektywy* Education Foundation, helps to convince women that gender should not be a factor determining the choice of studies. There is definitely no better opportunity than the *Year of Maria Skłodowska Curie* for the presentation of successful role models, such as that ingenious female scientist.

REFERENCES

1. Maria Skłodowska Curie - Unusual woman. Materials from an Exhibition at Jagiellonian University, Kraków, Poland, 12 May - 30 June (2011).
2. Durando, M., Wastiau, P. and Joyce, A., Women in IT. *European Schoolnet*, 18 October 2011, http://resources.eun.org/insight/Science_girls5.pdf
3. Eurostat, 18 October 2011, http://epp.eurostat.ec.europa.eu/portal/page/portal/education/data/main_tables
4. Girls as Engineers! (2011), (*Dziewczyny na politechniki* 2011), in Polish, 18 October 2011, <http://www.dziewczynynapolitechniki.pl>
5. Porębska, A., Dąbrowski, A.M., Mitkowski, S.A. and Kurgan, E., Female students - a challenge for technical universities. *Proc. 1st World Conf. on Technol. and Engng. Educ.*, Kraków, Poland, 14-19 (2010).
6. Gras-Velazquez, A., Joyce, A. and Debry, M., WHITE PAPER Women and ICT. Why are girls still not attracted to ICT studies and careers?, 18 October 2011, http://blog.eun.org/insightblog/upload/Women_and_ICT_FINAL.pdf
7. Competition *AGH Diamond Index* (Ogólnopolska Olimpiada: *O Diamentowy Indeks AGH*), in Polish, 18 October 2011, <http://moodle.cel.agh.edu.pl/diament/>
8. Girls' Day - Future Prospects for Girls, 18 October 2011, <http://www.girls-day.de>