



**Utilizing the Full Potential  
of Space for the Implementation  
of the Europe 2020 Strategy  
in the Field of Education**

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# Executive Summary

This report summarizes what is being done and identifies what more the space sector can potentially do to help attain the goals of the EU growth strategy “Europe 2020 for smart, sustainable and inclusive growth” in the fundamental policy area of education. The presentation of the multiple links between space activities and education shows the economic and social utility of space. In the first chapter, the report demonstrates the potential of underused space educational resources to support the attractiveness of STEM subjects in schools and presents ESA’s most important educational programme, ESERO. In the second chapter, the report analyses the multiple ways in which space can help in achieving the „Europe 2020“ targets in tertiary educa-

tion. It demonstrates that through the decisive contribution of space to the attainment of the Strategy’s target for universal broadband coverage, space technology creates the technical prerequisites for the utilization of distance education in all European regions, thus also supporting Europe’s territorial cohesion. In addition, because of their iconic and fascinating nature, space activities can motivate youth (including under-represented groups) towards the acquisition of those skills that a ‘smart economy’ needs most. In sum, through its interaction with higher education, the space sector can make a vital contribution to the quality and the relevance of Europe’s educational efforts.

# Preamble

In 2010, the European Union launched the growth strategy "Europe 2020: a strategy for smart, sustainable and inclusive growth" as the successor of the "Lisbon Strategy" for the decade 2000-2010.

While building on lessons learned from the implementation of the "Lisbon Strategy", the new strategy has maintained the core of the vision on the future of the EU economy declared by its predecessor. This vision is expressed by the "Europe 2020" as three priorities: (1) a smart economy, namely an economy based on knowledge and innovation; (2) a sustainable economy, namely a more resource efficient, greener and more competitive economy; (3) an inclusive economy, namely an economy which fosters employment, social and territorial cohesion.

In order to make this vision materialise by 2020, within the framework of the Strategy, the EU has (a) defined 5 headline targets in the policy areas of employment, research and

innovation, climate change and energy, education and combating poverty; and (b) underpinned those targets by putting forward 7 flagship initiatives, which call for a wide range of actions by the Commission, at EU level, and by the Member States at national level (See overview below).

The attainment of the headline targets and the successful implementation of the flagship initiatives require, according to the Commission, the involvement of all sections of society, including businesses, trade unions, non-governmental organizations and individual citizens. Whereas the utility of space for climate change policy or for the research and innovation policy could be characterized as obvious, the present report attempts to reveal the less obvious actual and potential contribution of space to the Strategy's goals in the fundamental field of education and hence to "Europe 2020"'s final objective to deliver high levels of employment, productivity and cohesion in the Member States.



# Europe 2020: An Overview

Headline targets		
<ul style="list-style-type: none"> <li>• Raise the employment rate of the population aged 20-64 from the current 69% to at least 75%. (<i>Employment</i>)</li> </ul>		
<ul style="list-style-type: none"> <li>• Achieve the target of investing 3% of GDP in R&amp;D in particular by improving the conditions for R&amp;D investment by the private sector, and develop a new indicator to track innovation. (<i>Research and Innovation</i>)</li> </ul>		
<ul style="list-style-type: none"> <li>• Reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are right, increase the share of renewable energy in our final energy consumption to 20%, and achieve a 20% increase in energy efficiency. (<i>Climate Change and Energy</i>)</li> </ul>		
<ul style="list-style-type: none"> <li>• Reduce the share of early school leavers to 10% from the current 15% and increase the share of the population aged 30-34 having completed tertiary education from 31% to at least 40%. (<i>Education</i>)</li> </ul>		
<ul style="list-style-type: none"> <li>• Reduce the number of Europeans living below national poverty lines by 25%, lifting 20 million people out of poverty. (<i>Combating Poverty</i>)</li> </ul>		
Flagship Initiatives		
<p><b>INNOVATION</b> EU flagship initiative “<b>Innovation Union</b>” to improve framework conditions and access to finance for research and innovation so as to strengthen the innovation chain and boost levels of investment throughout the Union.</p>	<p><b>CLIMATE, ENERGY AND MOBILITY</b> EU flagship initiative “<b>Resource efficient Europe</b>” to help decouple economic growth from the use of resources, by decarbonising our economy, increasing the use of renewable sources, modernising our transport sector and promoting energy efficiency.</p>	<p><b>EMPLOYMENT AND SKILLS</b> EU flagship initiative “<b>An agenda for new skills and jobs</b>” to modernise labour markets by facilitating labour mobility and the development of skills throughout the lifecycle with a view to increasing labour participation and better match labour supply and demand.</p>
<p><b>EDUCATION</b> EU flagship initiative “<b>Youth on the move</b>” to enhance the performance of education systems and to reinforce the international attractiveness of Europe’s higher education.</p>	<p><b>COMPETITIVENESS</b> EU flagship initiative “<b>An industrial policy for the globalisation era</b>” to improve the business environment, especially for SMEs, and to support the development of a strong and sustainable industrial base able to compete globally.</p>	<p><b>FIGHTING POVERTY</b> EU flagship initiative “<b>European platform against poverty</b>” to ensure social and territorial cohesion such that the benefits of growth and jobs are widely shared and people experiencing poverty and social exclusion are enabled to live in dignity and take active part in society.</p>
<p><b>DIGITAL SOCIETY</b> EU flagship initiative “<b>A digital agenda for Europe</b>” to speed up the roll-out of high-speed internet and reap the benefits of a digital single market for households and firms.</p>		

European Commission. Communication. EUROPE 2020. A strategy for smart, sustainable and inclusive growth. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

# Introduction

The education component of the current strategic framework for European cooperation in education and training, "Education and Training 2020" has two key sub-goals. One sub-goal is the reduction of the rate of early school and training leavers aged 18-24 from 14% in 2010 to 10% in 2020. This objective, like all headline targets of the "Europe 2020 Strategy", is tailored to each Member State's particular conditions. For instance, the respective national target for Spain, which is a country

with a high early school-leaving rate, is 15% while for Austria it is 9.5% (Table 1).

The other part of the "Europe 2020" educational headline target is to increase the share of the Union's population aged 30-34 having completed tertiary (i.e. university or university-like) education from 33% (2010) to 40% by the end of the current decade. The respective national target for Romania is 26.7%, whereas for France it is 50% and for Ireland 60% (Table 2).

Early Leavers from Education and Training (age group 18-24)					
	2010	2011	2012	2013	2020 Target
EU (28 countries)	13.9	13.4	12.7	11.9	10
Belgium	11.9	12.3	12	11	9.5
Bulgaria	13.9	11.8	12.5	12.5	11
Czech Republic	4.9	4.9	5.5	5.4	5.5
Denmark	11	9.6	9.1	8	10
Germany	11.9	11.7	10.6	9.9	10
Estonia	11.6	10.9	10.5	9.7	9.5
Ireland	11.5	10.8	9.7	8.4	8
Greece	13.7	13.1	11.4	10.1	9.7
Spain	28.4	26.5	24.9	23.5	15
France	12.6	12	11.6	9.7	9.5
Croatia	3.7	4.1	4.2	3.7	4
Italy	18.8	18.2	17.6	17	16
Cyprus	12.7	11.3	11.4	9.1	10
Latvia	13.3	11.6	10.6	9.8	13.4
Lithuania	7.9	7.4	6.5	6.3	9
Luxembourg	7.1	6.2	8.1	6.1	10
Hungary	10.5	11.2	11.5	11.8	10
Malta	25.9	23.6	22.6	20.9	10
Netherlands	10	9.1	8.8	9.2	8
Austria	8.3	8.3	7.6	7.3	9.5
Poland	5.4	5.6	5.7	5.6	4.5
Portugal	28.7	23.2	20.8	19.2	10
Romania	18.4	17.5	17.4	17.3	11.3
Slovenia	5	4.2	4.4	3.9	5
Slovakia	4.7	5.1	5.3	6.4	6
Finland	10.3	9.8	8.9	9.3	8
Sweden	6.5	6.6	7.5	7.1	10
United Kingdom	14.9	15	13.6	12.4	:

Table 1: Early Leavers from Education and Training. Source: EUROSTAT  
[http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020\\_40&plugin=1](http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_40&plugin=1).



Tertiary educational attainment (age group 30-34)					
	2010	2011	2012	2013	2020 Target
EU (28 countries)	33.4	34.5	35.7	36.8	40
Belgium	44.4	42.6	43.9	42.7	47
Bulgaria	27.7	27.3	26.9	29.4	36
Czech Republic	20.4	23.7	25.6	26.7	32
Denmark	41.2	41.2	43	43.4	40
Germany	29.8	30.7	32	33.1	42
Estonia	40	40.3	39.1	43.7	40
Ireland	50.1	49.7	51.1	52.6	60
Greece	28.4	28.9	30.9	34.6	32
Spain	40.6	40.6	40.1	40.7	44
France	43.5	43.3	43.6	44	50
Croatia	24.3	24.5	23.7	25.9	35
Italy	19.8	20.3	21.7	22.4	26
Cyprus	45.3	46.2	49.9	47.8	46
Latvia	32.3	35.9	37.2	40.7	34
Lithuania	43.8	45.7	48.6	51.3	40
Luxembourg	46.1	48.2	49.6	52.5	66
Hungary	25.7	28.1	29.9	31.9	30.3
Malta	21.5	21.4	22.4	26	33
Netherlands	41.4	41.1	42.2	43.1	40
Austria	23.5	23.8	26.3	27.3	38
Poland	34.8	36.5	39.1	40.5	45
Portugal	23.5	26.1	27.2	29.2	40
Romania	18.1	20.4	21.8	22.8	26.7
Slovenia	34.8	37.9	39.2	40.1	40
Slovakia	22.1	23.2	23.7	26.9	40
Finland	45.7	46	45.8	45.1	42
Sweden	45.3	46.8	47.9	48.3	40
United Kingdom <sup>1</sup>	43	45.8	47.1	47.6	

Table 2: Tertiary Educational Attainment by Sex, Age Group 30-34; Source: EUROSTAT, 7 March 2014.  
[http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020\\_41&plugin=1](http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_41&plugin=1)

The vast majority of EU Member States have reported large-scale initiatives for at least one of the two sub-goals of the headline tar-

get<sup>2</sup> and the progress towards them, since the launch of the Strategy in 2010, indicates that they are both broadly achievable at EU

<sup>1</sup> As in the areas of employment and R&D, the United Kingdom did not set any national targets for tertiary education and early-school leaving.

<sup>2</sup> European Commission/EACEA/Eurydice, 2013. Education and Training in Europe 2020: Responses from the EU Member States. Eurydice Report. Brussels: Eurydice. p. 20 & 37.

level by 2020.<sup>3</sup> Nevertheless, as the European Commission has declared, the headline targets are representative but not exhaustive of the Strategy's 3 priorities (i.e. smart, sustainable and inclusive growth). Therefore, the targets are supplemented by the 7 flagship initiatives,<sup>4</sup> which also form part of Europe 2020 Strategy.<sup>5</sup>

Accordingly, the present report will detail what is being done and what could be done in the space sector to help achieve not only the headline target in education, but also: (1) the objectives of "Youth on the Move" and the other flagship initiatives, which are related to education; (2) what space does or is able to do in order to help education contribute to other headline targets (e.g. increase of employment), considering the interrelationship between the targets; (3) other activities that space does or could do to contribute through the field of education to the Strategy's ultimate goal, which is to turn the EU into a smart, sustainable and inclusive economy.

The report has the following structure: the first chapter refers to Pre-Tertiary (Primary and Secondary) Education to which the issue of Early School Leaving applies. The second chapter analyses the current and potential contribution that space could make to the Strategy's goals in the area of the Tertiary Education.

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<sup>3</sup> European Commission. Communication. Taking Stock of the Europe 2020 Strategy for Smart, Sustainable and Inclusive Growth. COM (2014) 130 final of 5 March 2014. Brussels: European Union.

<sup>4</sup> These are: Innovation Union, Youth on the Move, Digital Agenda for Europe, Resource-efficient Europe, Industrial Policy for the Globalization Era, Agenda for New Skills and Jobs, European Platform for Poverty.

<sup>5</sup> European Commission. Communication. EUROPE 2020. A strategy for smart, sustainable and inclusive growth. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.



# 1. Pre-Tertiary Education

## 1.1. Early School Leaving and Low-Achievement in Basic Skills

According to the definition of the European Union, early school leavers are not citizens with uncompleted compulsory schooling. Rather, the definition includes all young European adults (age group 18-24) who are not currently participating in education or training while having achieved only pre-primary, primary, lower secondary or short upper secondary education (of less than 2 years).<sup>6</sup> For the Union, the completion of the second year of upper secondary education constitutes the minimum of education needed by young people in Europe and the lack thereof is considered to have lifetime consequences on them and to negatively affect societies and economies.<sup>7</sup>

Specifically, early school leaving considerably raises the risk of unemployment. For instance, in 2012 the average unemployment rate of early school leavers was 40.1% compared to the 23.2% overall youth unemployment rate in Europe.<sup>8</sup> Besides, the same social group faces a higher poverty risk. In 2009, early school leavers and older citizens who had not completed upper secondary education (aged 18-59) faced 10% higher probability of poverty than those with medium level education and 20% higher than tertiary education graduates (Figure 1). It is noteworthy that the risk of poverty results not only from high unemployment rates but also from low-wage

employment (in-work poverty).<sup>9</sup> From this it is evident that the largest possible decrease of the share of early school leavers would be valuable for attaining the Strategy's headline targets in the areas of employment and poverty, which are the most instrumental targets for the realization of the priority of "inclusive growth".<sup>10</sup>

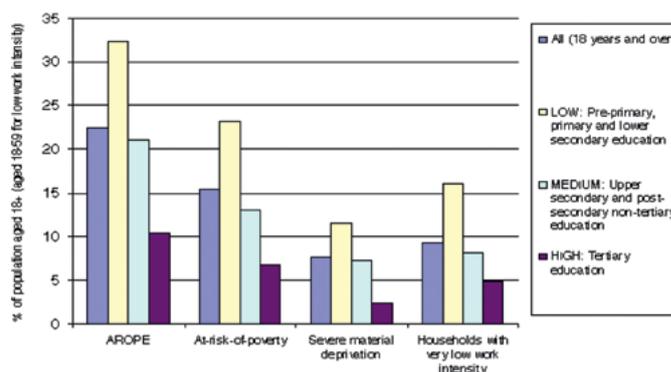


Figure 1: People aged 18 and over at-risk-of-poverty or exclusion by level of education. Source: European Commission. DG for Employment, Social Affairs and Inclusion. The Social Dimension of the Europe 2020 Strategy. A Report of the Social Protection Committee (2011). Luxembourg: Publications Office of the European Union.

In addition, since the acquisition of the minimum of education, as defined by the European Commission, constitutes the condition sine qua non for the entry of youngsters either into tertiary education or into vocational education and training (post-secondary/non-tertiary level), the reduction of early school leaving can, firstly, contribute to the achievement of the second part of the Strategy's educational headline target, which requires wider access into higher education and, secondly, it can help the implementation of the "Youth on the Move" flagship initiative, which focuses, inter alia, on the development of key competences and on the extension of learning opportunities for youth, putting emphasis on vocational

<sup>6</sup> "Early School Leaving in Europe- Questions and Answers." 31 Jan. 2011. European Commission 12 November 2014 [http://europa.eu/rapid/press-release\\_MEMO-11-52\\_en.htm](http://europa.eu/rapid/press-release_MEMO-11-52_en.htm).

<sup>7</sup> European Commission. Communication. Tackling Early School Leaving: A Key Contribution to the Europe 2020 Agenda. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

<sup>8</sup> "Europe 2020 Target: Early Leavers from Education and Training." European Commission 12 November 2014 <[http://ec.europa.eu/europe2020/pdf/themes/29\\_early\\_school\\_leaving.pdf](http://ec.europa.eu/europe2020/pdf/themes/29_early_school_leaving.pdf)>.

<sup>9</sup> European Commission. DG for Employment, Social Affairs and Inclusion. The Social Dimension of the Europe 2020 Strategy. A Report of the Social Protection Committee (2011). Luxembourg: Publications Office of the European Union.

<sup>10</sup> European Commission. Communication. EUROPE 2020. A strategy for smart, sustainable and inclusive growth. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

education and training.<sup>11</sup> Thirdly, as a result of the previously mentioned factors, it forms the basis for a more skilled workforce, which is one of the main objectives of the "Agenda for New Skills and Jobs".<sup>12</sup> For all these reasons, to meet the first sub-goal of the headline target must be regarded as essential also for the materialization of the Strategy's smart (knowledge-driven) growth priority.

The aforementioned demonstrates the fundamentality of this sub-goal for the implementation of the "Europe 2020 Strategy" as a whole. Nevertheless, despite its importance, the first segment of the educational headline target cannot be regarded as a sufficient goal for Europe's primary and secondary education. In fact, even in countries where early school leaving rates appear small, there is no guarantee that the education systems have equipped every school graduate with the necessary competences.<sup>13</sup> Therefore, the policies of the Member States to address the early school leaving issue should encompass efforts to ensure that all adolescents attain an adequate level of basic skills. Although there is no measurable target within "Europe 2020" for this, the EU "Strategic Framework for European Cooperation in Education and Training (ET2020)" contains a pertinent benchmark: that, by 2020, the share of low-achieving, 15-year-olds in reading, mathematics and science should be less than 15%. For the assessment of pupils' performance, the Commission uses the results of the OECD's Programme for International Student Assessment (PISA).<sup>14</sup>

According to the PISA survey, the percentage of low achievers in reading declined from 19.7% in 2009 to 17.8% in 2012. This progress gives grounds for optimism that the 2020 benchmark of 15% will be reached providing that national efforts are sustained. This is also the case in science, where the respective percentage dropped from 17.8% in 2009 to 16.6% in 2012, which is relatively close to the benchmark. However, the PISA results of Europeans in mathematics could be characterized as disheartening. In 2009, the propor-

tion of low achieving pupils was 22.3% and no substantial progress was achieved in the three years that followed as, in 2012, the percentage decreased only to 22.1%.

The proportion of 15-year-olds not reaching a minimum level of basic skills in mathematics is lower in the EU than in the U.S. (25.8%) and the Russian Federation (24%) but still almost as high as the OECD average (23%) and twice as high as that of Japan (11.1%), while Hong Kong and Korea have only 8.5% and 9.1% respectively.<sup>15</sup> Also, it should be noted that in three EU Member States (Bulgaria, Cyprus and Romania) the percentages of low achievers in mathematics are almost double the OECD average (Table 1). The shares of low achieving 15-year-olds are indications of the efficacy of teaching methods applied in primary and lower secondary education in each country and of their capacity to engage children and young adolescents. Given that the understanding of mathematics is considered to be essential for the successful professional and social life of individuals and for the development of human capital, which is necessary for facing the challenges of global competition, the above data should be regarded as alarming for the European Union and prompt significant policy reforms in the primary and secondary level of education.<sup>16</sup>

<sup>11</sup> AROPE: at-risk-of-poverty or exclusion.

<sup>12</sup> European Commission. Communication. An Agenda for New Skills and Jobs: A European Contribution towards Full Employment. COM (2010) 682 final of 23 November 2010 Strasbourg: European Union.

<sup>13</sup> Lamb, Stephen, and Eifred Markussen. "School Dropout and Completion: An International Perspective." *School Dropout and Completion. International Comparative Studies in Theory and Policy*. Eds. Stephen Lamb, Eifred Markussen, Richard Teese et al. Milton Keynes: SpringerDordrechtHeidelberg, 2010. 1-20.

<sup>14</sup> Council of the EU. "Council Conclusions of 12 May 2009 on a Strategic Framework for European Cooperation in Education and Training (ET 2020)". Official Journal of the European Union C 119/2. 28 May 2009. Brussels: European Union.

<sup>15</sup> "PISA Results from PISA 2012. Country Note: Japan." wOECD 3 December 2012 [www.oecd.org/pisa/keyfindings/PISA-2012-results-japan.pdf](http://www.oecd.org/pisa/keyfindings/PISA-2012-results-japan.pdf).

<sup>16</sup> European Commission. DG for Education and Culture. Executive Summary: "PISA 2012: EU Performance and First Inferences regarding Education and Training Policies in Europe." 3 December 2013. Brussels: European Union.



## Progress towards the benchmark of less than 15% low achievers in reading, maths and science among 15 year olds

	2012	Evolution 2009-12	2012	Evolution 2009-12	2012	Evolution 2009-12
	Reading	(% points)	Maths	(% points)	Science	(% points)
<b>EU</b>	<b>17.8</b>	<b>-1.9</b>	<b>22.1</b>	<b>-0.2</b>	<b>16.6</b>	<b>-1.2</b>
Belgium	16.1	-1.5	19.0	-0.2	17.7	-0.4
Bulgaria	39.4	-1.6	43.8	-3.3	36.9	-1.9
Czech Republic	16.9	-6.2	21.0	-1.3	13.8	-3.5
Denmark	14.6	-0.6	16.8	-0.3	16.7	0.1
Germany	14.5	-4.0	17.7	-0.9	12.2	-2.6
Estonia	9.1	-4.2	10.5	-2.1	5.0	-3.3
Ireland	9.5	-7.6	16.9	-3.9	11.1	-4.1
Greece	22.6	1.3	35.7	5.4	25.5	0.2
Spain	18.3	-1.3	23.6	-0.1	15.7	-2.5
France	18.9	-0.9	22.4	-0.1	18.7	-0.6
Croatia	18.7	-3.7	29.9	-3.3	17.3	-1.2
Italy	19.5	-1.5	24.7	-0.2	18.7	-1.9
Cyprus	32.8	:	42.0	:	38.0	:
Latvia	17.0	-0.6	19.9	-2.7	12.4	-2.3
Lithuania	21.2	-3.2	26.0	-0.3	16.1	-0.9
Luxembourg	22.2	-3.8	24.3	0.4	22.2	-1.5
Hungary	19.7	2.1	28.1	5.8	18.0	3.9
Malta	:	:	:	:	:	:
Netherlands	14.0	-0.3	14.8	1.4	13.1	-0.1
Austria	19.5	-6.0	18.7	-4.5	15.8	-5.2
Poland	30.6	-4.4	14.4	-6.1	9.0	-4.1
Portugal	18.8	1.2	24.9	1.2	19.0	2.5
Romania	37.3	-3.1	40.8	-6.2	37.3	-4.1
Slovenia	21.1	-0.1	20.1	-0.2	12.9	-1.9
Slovakia	28.2	6.0	27.5	6.5	26.9	7.6
Finland	11.3	3.2	12.3	4.5	7.7	1.7
Sweden	22.7	5.3	27.1	6.0	22.2	3.1
UK	16.6	-1.8	21.8	1.6	15.0	0.0

Table 1. Source: OECD, PISA 2012.

European Commission. Press Release: "EU School Support: Some Improvement in Science and Reading but Poor in Maths." 3 Dec.2013. Brussels: European Union.  
[http://europa.eu/rapid/press-release\\_IP-13-1198\\_en.htm](http://europa.eu/rapid/press-release_IP-13-1198_en.htm)

There is a correlation between the issues of early school leaving and low achievement in basic skills. While abandoning education too early does not allow the individual to acquire basic skills at a sufficient level, the obtainment of basic skills from early age decreases the probability that a pupil will face scholastic failure or difficulties that can lead him or her to abandoning education and training. In order to tackle both issues, the Member States should at first identify their root causes. The Commission has identified 3 categories of influencing factors: (a) individual circumstances; (b) socio-economic conditions; and (c) educational factors.<sup>17</sup>

The first category of factors comprises individual characteristics such as learning difficulties, health (including mental health, behavioural and emotional problems such as lack of self-esteem) and disability.<sup>18</sup> Undoubtedly, these characteristics or their impact on pupils' performances and attitudes can be modified

<sup>17</sup> European Commission. Communication. Tackling Early School Leaving: A Key Contribution to the Europe 2020 Agenda. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

<sup>18</sup> cf. Lamb, Stephen. "School Dropout and Inequality." School Dropout and Completion. International Comparative Studies in Theory and Policy. Eds. Stephen Lamb, Eifred Markussen, Richard Teese et al. Milton Keynes: SpringerDordrechtHeidelberg, 2010. 369-390.

by the educational and social policies of Member States through adequate measures. Such measures include tutoring, mentoring, and welfare support.<sup>19</sup> Nonetheless, individual factors resulting in school dropout will always exist. Therefore, one has to be aware that even the best possible educational system in the best-functioning welfare state will not entirely eliminate this issue.

Concerning the impact of socio-economic conditions, it is indisputable that a low educational level of parents and low family income increase the probability of low achieving and early school leaving. Scarce skills and low earnings are, thus, reproduced from one generation to the next. Additionally, pupils with migration background face an increased risk of dropping out. This group is often disadvantaged due to imperfect command of the language in which courses are conducted. Within a comprehensive policy for integration, targeted language assistance to such children could be an effective tool in reducing scholastic underachievement and partially restoring equality.<sup>20</sup>

While acknowledging social inequality as a determinant of low achievement in basic skills and school dropout, the present report concentrates on the third group of factors, which can be positively influenced by space educational resources. These factors lie within the nature of the educational experience. Both problems are related to the effectiveness and attractiveness thereof. The inability of school to capture interest and transmit knowledge and skills to different types of learners results in the failure and disengagement of many of them, who subsequently become low achievers or early school leavers. The proper utilization of space educational resources can have a favourable impact on the quality of primary and secondary education by enhancing their attractiveness and effectiveness. By making the education process more attractive, space can help prevent disengagement and increase pupils' motivation for better performance. By helping the effectiveness of knowledge and skills transmission, especially in the most demanding subjects, space can help prevent low achievement and failure.

<sup>19</sup> cf. Markussen, Eifred, and Nina Sandberg. "Policies to Reduce School Dropout and Increase Completion." School Dropout and Completion. International Comparative Studies in Theory and Policy. Eds. Stephen Lamb, Eifred Markussen, Richard Teese et al. Milton Keynes: SpringerDordrechtHeidelberg, 2010. 391-405.

<sup>20</sup> European Commission. Communication. Tackling Early School Leaving: A Key Contribution to the Europe 2020 Agenda. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

## 1.2. Space as Part of the Solution

Education has been a part of the mission of space agencies since their first establishment. The relation of space to education can be identified in the "National Aeronautics and Space Act of 1958", whereby NASA was created.<sup>21</sup> Education is also one of ESA's basic activities as stated in the ESA Convention.<sup>22</sup> Nowadays, similar to NASA and ESA, almost all space agencies incorporate education offices responsible for running educational programmes.

The inherent link of space to education consists firstly, in the fact that all technical accomplishments in space are founded on excellence in STEM (i.e. science, technology, engineering and mathematics) education;<sup>23</sup> and secondly, in the fact that most types of space activities, in parallel with their main function, can be utilized for the development of educational resources (i.e. material for teaching and learning) usable at all educational levels and in a wide range of subjects, particularly STEM.

With regard to STEM, it is noteworthy that the majority of Europeans find the way these subjects are taught at school problematic. According to the Special Eurobarometer "Europeans, Science and Technology" conducted in the middle of the 2000's the previous decade, only 15% were satisfied with the quality of STEM classes at school. In addition, in another survey, 59.5% answered that such classes are not sufficiently appealing.<sup>24</sup> As previously mentioned, this lack of allure is a factor related to the issues of low performances and school dropout. In this respect, space-based educational material can be a particularly valuable asset to the school curricula thanks to its capacity to attract youth interest and stimulate motivation.<sup>25</sup> The contribution of space educational resources to primary and secondary education is the topic of the present

section. The examples used are derived from ESA's educational resources. Notwithstanding, substantial educational material is provided also by Europe's national space agencies.

The usage of Earth Observation data in order to support the subjects of geography, environmental sciences and physics<sup>26</sup> provides an example of space-based teaching and learning. For pedagogic use of the outcome of Earth Observation, ESA has created the website "Eduspace" as an entry point to satellite imagery for teachers and learners in secondary education. In addition to a rich catalogue of images, "Eduspace" puts at the disposal of its users sophisticated image processing software.<sup>27</sup> Additionally, the website contains exercises and case studies on subjects such as weather and climate, climate change and disaster monitoring. The contents of "Eduspace", available in 9 European languages, constitute some of ESA's most used educational resources.<sup>28</sup> Apart from the website "Eduspace", there are several classroom resources based on Earth Observation available on ESA's Web-Pages. Apart from Earth Observation and its impressive images of our planet, the Agency has made available on the Internet classroom resources material on several thematic areas: solar system and universe, rockets technology and resources, astronauts and the International Space Station.<sup>29</sup>

The educational resources based on space exploration missions are regarded as particularly captivating and inspiring. A case in point is the educational material on ESA's recent and much discussed "Rosetta" mission, whose purpose was the study from close proximity of the Comet 67P/Gerasimenko. The Agency made the teaching material available through the website "Teach with Rosetta". The website comprises information and educational resources suitable for what is called Inquiry-Based Science Education (IBSE). This term refers to an educational approach that gives more room for the pupils' involvement in teacher-guided experimentation instead of the direct transmission of scientific concepts

<sup>21</sup> „National Aeronautics and Space Act." U.S. Government Printing Office 30 November 2014 <<http://www.gpo.gov/fdsys/pkg/STATUTE-72/pdf/STATUTE-72-Pg426-2.pdf>>

<sup>22</sup> ESA Convention and Council Rules of Procedure. Netherlands: ESA Communications, 2010

<sup>23</sup> „About NASA's Education Programme." NASA 3 December 2014 <<http://www.nasa.gov/offices/education/about/>>

<sup>24</sup> European Commission. Rocard, Michel, Peter Chermely, Doris Jorde et al. Science Education Now: A Renewed Pedagogy for the Future of Europe. Luxembourg: Office for Official Publications of the European Communities, 2007

<sup>25</sup> Quinn, Helen R., Heidi A. Schweingruber, and Michael A. Feder, eds. NASA's Elementary and Secondary Education Program: Review and Critique. Washington, D.C.: The National Academies Press, 2008

<sup>26</sup> „Eduspace." European Space Agency 7 December 2014

<sup>27</sup> „About Eduspace. What Tools Does It Offer?" 3 July 2013 European Space Agency 7 December 2014 <[http://www.esa.int/SPECIALS/Eduspace\\_EN/SEMNNBAN-JTF\\_2.html](http://www.esa.int/SPECIALS/Eduspace_EN/SEMNNBAN-JTF_2.html)>

<sup>28</sup> „Education. Inspiring the Future." European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EduSuccess.pdf>>

<sup>29</sup> „Teacher's Corner." 20 Dec. 2012 European Space Agency 10 December 2014 <[http://www.esa.int/Education/Teachers\\_Corner/Earth\\_and\\_Environment](http://www.esa.int/Education/Teachers_Corner/Earth_and_Environment)>



from teachers to pupils.<sup>30</sup> For instance, “Teach with Rosetta” provides teachers at secondary school level with instructions for the development of hands-on activities: “Cooking a Comet”, aimed at making students familiar with the basic compositional parameters of comets; and “Marble-ous Ellipses”, an activity on orbiting bodies, which gives a space setting to speed-time graphs used in physics and mathematics.<sup>31</sup>

It has been shown that IBSE activities, such as the above, are to a certain extent capable of demolishing the misconception that science is only for geniuses. Thus, they encourage students with lower levels of self-confidence as well as those belonging to disadvantaged groups. Furthermore, it has been observed that this method increases the motivation of female pupils. Besides, hands-on activities, in particular, are obviously preferable for the type of pupils who are motivated by active forms of learning (learning-by-doing).<sup>32</sup> Finally, there is evidence that this method can also stimulate enthusiasm in educators.<sup>33</sup> Thanks to the exciting nature of space, its combination with the IBSE method can enhance the positive influence of the latter on the engagement of learners and teachers and thereby optimize the educational outcome.

In addition to educational resources applicable to high-school STEM education, the website “Teach with Rosetta” contains entertaining educational materials designed for the primary school level. While being STEM-related, this material goes beyond STEM by covering activities such as writing, art and design. Therefore, it can be characterized as an application of a relatively new educational concept, called STEAM. This acronym signifies the incorporation of Art into STEM. Art is considered to

have a universal appeal, which could augment the attractiveness of STEM subjects.<sup>34</sup>

Since primary school corresponds to the time of construction of intrinsic motivation with long-lasting effects,<sup>35</sup> the availability to primary school teachers of material able to contribute to the development of a positive attitude of children towards the most difficult subjects is of fundamental importance for the reduction of the problems of low achieving and early school leaving. In fact, early school leaving, despite being an event that in most cases occurs when the student has already reached the secondary level of education, needs rather to be seen as a process of growing alienation starting from early childhood educational experiences.<sup>36</sup>

Following the principle “the earlier the better”, ESA has also created a website targeting children from the age of 4, named “ESA Kids”. The “ESA Kids” WebPages are designed to develop children’s interest in space, while making them familiar with basic concepts of spaceflight through simple text, images, videos, games and creative activities. The website is a contribution by the Agency to informal (outside the classroom) learning.<sup>37</sup> Finally, a further example is the website “ESA/ESO Astronomy Exercise Series”, which contains exercises produced by both ESA and the European Southern Observatory.<sup>38</sup>

The material contained on the aforementioned websites is no more than a small sample of the wealth of space-based educational resources that are freely available online. The extent to which European students actually take advantage of these resources is questionable. In fact, between 50% and 80% of students in the EU never use digital textbooks, exercise software, videos or learning games. The European Commission underlines the under-exploitation of learning material in digital form as one of the causes of Europe’s professional ICT (i.e. Information and Communication Technology)

<sup>30</sup> European Commission. Rocard, Michel, Peter Chermely, Doris Jorde et al. *Science Education Now: A Renewed Pedagogy for the Future of Europe*. Luxembourg: Office for Official Publications of the European Communities, 2007.

<sup>31</sup> “Rosetta and Education.” 16 October 2014 European Space Agency 30 Nov. 2014 <[http://www.esa.int/Education/Teach\\_with\\_Rosetta/Rosetta\\_and\\_Education](http://www.esa.int/Education/Teach_with_Rosetta/Rosetta_and_Education)>.

<sup>32</sup> European Commission. Communication. *Tackling Early School Leaving: A Key Contribution to the Europe 2020 Agenda*. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

<sup>33</sup> European Commission. Rocard, Michel, Peter Chermely, Doris Jorde et al. *Science Education Now: A Renewed Pedagogy for the Future of Europe*. Luxembourg: Office for Official Publications of the European Communities, 2007.

<sup>34</sup> Boy, Guy André; Alexandre Lasslop, and Yasemin Baydaroglu, eds. *TS Report: Space. One Giant Leap for Education*. Strasbourg: International Space University, 2012.

<sup>35</sup> European Commission. Rocard, Michel, Peter Chermely, Doris Jorde et al. *Science Education Now: A Renewed Pedagogy for the Future of Europe*. Luxembourg: Office for Official Publications of the European Communities, 2007.

<sup>36</sup> European Commission. Communication. *Tackling Early School Leaving: A Key Contribution to the Europe 2020 Agenda*. COM (2010) 2020 final of 3 March 2010. Brussels: European Union.

<sup>37</sup> Education. *Inspiring the Future.* European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf>>.

<sup>38</sup> “The ESA/ESO Astronomy Exercise Series.” 9 December 2014 <<http://www.astroex.org/english/>>.

shortage and digital literacy deficit.<sup>39</sup> The latter is an issue that Europe, according to the Strategy's flagship initiative "Digital Agenda", has to tackle. Consequently, the further utilization of educational resources such as those presented above would also serve the implementation of the "Digital Agenda's" objective to improve the digital literacy and competences of the European population.<sup>40</sup>

In addition to supplying educational resources, ESA organises Europe-wide competitions such as the annual "CanSat" competition. The challenge in this competition is the following: teams of secondary students have to fit inside a soft drink can all essential subsystems of a satellite (power, communications etc.). The can satellite is then either launched by a small rocket or dropped from a balloon. Although it does not reach space, this simulation of a real satellite has to perform a certain mission and land back on the ground safely.<sup>41</sup> The "CanSat" project helps the development of skills such as scientific inquiry, technical design, data analysis, presentation and teamwork as well as more practical skills such as soldering, building electronics, software programming, and testing.<sup>42</sup> Through such hands-on activities, pupils learn to apply the knowledge they have acquired. This is also what the PISA survey tries to assess: not merely the amount of knowledge accumulated by each country's 15-year-olds but the extent to which they can apply it when confronted with situations and challenges for which this knowledge may be relevant.<sup>43</sup>

Clearly, no benefit from the variety of possibilities described above can be had without the awareness of their existence. Actually, teachers' lack of awareness is the main reason for the under-utilization of educational resources based on space. A survey conducted in Austria, an ESA and EU Member State, clearly demonstrates the issue: 91.3% of secondary school teachers answered that they had never used materials provided by ESA on its webpage because they were not aware of them

(Table 2). Hence, an effective strategy to raise awareness among teachers with regard to the possibilities offered to them by space should be regarded as indispensable.

<b>Do you use the teaching material provided on ESA's homepage?</b>	
Yes	5.3%
No, the material is not suitable	3.4%
No, I am not aware of those resources	91.3%

Table 2. Source: Habison, Peter. "Astronomy and Space in Curricula towards a Continental Education." *European Identity through Space. Space Activities and Programmes as a Tool to Reinvigorate the European Identity*. Eds. Christophe Venet, Blandina Baranes. Vienna: SpringerWien-NewYork, 2012.

Training programmes are an effective tool for creating awareness about the educational material offered by ESA. It is worth mentioning that the Commission has stressed the importance of the recruitment and development of well-qualified staff as preconditions for improvement of quality education.<sup>44</sup> The European Space Agency contributes to the career-long development of European teachers by organising training programmes mostly aimed at the use of space as a context for teaching several subjects. An example is "ESA's Summer Teacher Workshop". Each summer, 40 teachers from across Europe are trained in this workshop at ESA's facility, ESTEC (European Space Research and Technology Centre).<sup>45</sup> Nevertheless, such workshops, conducted at European level, are not capable of meeting the needs of the immense number of teachers and pupils of the 20 Member States of ESA. Therefore, to respond to the greatest possible extent to the needs of its Member States, ESA follows a de-centralising approach. This is the approach of the "ESERO" project, presented and discussed below.

<sup>39</sup> European Commission. Communication. Opening Up Education: Innovative Teaching and Learning for all Through New Technologies and Open Educational Resources. COM (2013) 2020 final of 25 September 2013. Brussels: European Union.

<sup>40</sup> European Commission. Communication. A Digital Agenda for Europe. COM (2010) 245 final of 19 May 2010. Brussels: European Union.

<sup>41</sup> „Education. Inspiring the Future.” European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf>>.

<sup>42</sup> „Education. Inspiring the Future.” European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf>>.

<sup>43</sup> OECD. PISA 2012. Technical Report. Paris: OECD, 2014:22.

<sup>44</sup> European Commission. Communication. Rethinking Education: Investing in Skills for Better Socio-Economic Outcomes. COM (2012) 2020 final of 20 November 2012. Strasbourg: European Union.

<sup>45</sup> „Education. Inspiring the Future.” European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf>>.



### 1.3. *The European Space Education Resource Office (ESERO)*

Education in Europe is mainly characterized by its diversity. This is partially because, throughout the history of the European integration process, the national states decided to maintain their full sovereignty in this policy area. Even the Treaty of Lisbon does not confer on the European Union a legislative competence allowing, to a certain degree, the harmonization of the varied educational systems. Instead, the Union's competence in this field is limited to "actions to support, coordinate or supplement the actions of the Member States" (Art. 6 TEU).

Considering the heterogeneity of the European education systems and school curricula as well as the 15 different languages and the vast number of pupils and teachers, the European Space Agency has adopted a "member-state-to-member-state" approach in order to effectively support the education communities of its member states. In other words, the Agency decided to tailor its support to the needs and priorities of each national education system. The tool for the implementation of this approach is ESA's largest educational programme so far, the European Space Education Resource Office initiative.

ESA signed the first ESERO contract with the Dutch science centre NEMO (National Science and Technology Centre) in Amsterdam in 2005. In the following year, the first European Space Resource Education Office was opened at NEMO. At the official opening of the office, the Dutch Minister of Education, Culture and Science stated: „We need to do this at national level. We need to establish a link between the national education systems and ESA, so we have decided to create this ESERO project.”<sup>46</sup>

Since then, ESA has established 9 ESERO national offices covering the needs of 12 of its Member States. These are, apart from ESERO Netherlands: ESERO Belgium, UK, Ireland, Portugal, Romania, Poland, Czech Republic and the Nordic ESERO. The latter covers the four Nordic countries of ESA, namely Denmark, Finland, Norway and Sweden. All offices are co-funded by ESA and national authorities

(Table 3) and are staffed by local experts who work in strong synergy and partnership with the national education authorities and networks.<sup>47 48</sup>

<sup>46</sup> "Opening of Europe's First Space Education Resource Office." 20 April 2006 European Space Agency 2 December 2014 <[http://www.esa.int/Education/Teachers\\_Corner/Opening\\_of\\_Europe\\_s\\_first\\_space\\_education\\_resource\\_office](http://www.esa.int/Education/Teachers_Corner/Opening_of_Europe_s_first_space_education_resource_office)>

<sup>47</sup> European Space Education Resource Office." European Space Agency 2 June 2014 <[http://www.esa.int/Education/Teachers\\_Corner/European\\_Space\\_Education\\_Resource\\_Office](http://www.esa.int/Education/Teachers_Corner/European_Space_Education_Resource_Office)>

<sup>48</sup> Schrogl, Kai-Uwe. „The Sky is Not the Limit- Faszination Weltraum für die Jugend.“ Presentation. Space Day 2014. 50 Years of European Co-operation and Innovation in Space

European Space Educational Resources Offices (ESEROs)		
	Co-Funded by	Seat
ESERO NL	Dutch Space Office (NSO)	Amsterdam
ESERO BE	Royal Observatory & Belgian Federal Science Policy Office (Belspo)	Brussels
ESERO UK	Department for Education (DfE), Science and Technologies Facilities Council, UK Space Agency & Myscience.co Ltd	York
ESERO IE	Science Foundation Ireland (SFI)	Dublin
ESERO PT	Portuguese Agency for Scientific and Technological Culture (Ciência Viva)	Lisbon
ESERO RO	Romanian Space Agency (ROSA)	Bucharest
ESERO PL	Copernicus Science Centre	Warsaw
Nordic ESERO	Norwegian Center for Space-related Education, Norwegian Space Center, University of Nordland, Kongsberg Satellite Services, Tycho Brahe Planetarium, Swedish National Space Board & Finnish National Board of Education	Andenes (Norway)
ESERO CZ	Czech Scientica Agency, Charles University of Prague, Astronomical Institute of the Academy of Sciences of the Czech Republic, Tereza Association, IQ Landia Science Centre Labyrinth Bohemia and the Prague City Hall	Prague

Table 3: European Space Education Resource Office." European Space Agency, 2 June 2014 <[http://www.esa.int/Education/Teachers\\_Corner/European\\_Space\\_Education\\_Resource\\_Office](http://www.esa.int/Education/Teachers_Corner/European_Space_Education_Resource_Office)>

Each ESERO coordinates an annual series of national or regional training sessions for both primary and secondary teachers with regard to the utilization of space-based educational material.<sup>49</sup> The offices do not just disseminate the existing teaching resources offered by ESA. They also adapt them to the specific curricula and languages. Additionally, they produce new resources in collaboration with national experts.<sup>50</sup> An example of teaching material created by an ESERO, is the book "Travel to Space in 80 lessons" by ESERO Netherlands. The book was written for teaching children in the age group 4-12. It uses the IBSE method and it has proved to be very apt for the Dutch curricula. Encouraged by this achievement, the Dutch ESERO has announced the launch of a new 40-lesson pack for secondary school teachers.<sup>51</sup> The supervision and advice provided by ESA assure the accuracy of the material and the coherence of the offices' activities. Finally, within the international ESERO network, the educators also have the opportunity to exchange knowledge, practices and ideas.

ESEROs' activities are expected to help European educators utilize the full potential of the alluring space context to motivate students and improve their literacy in STEM. Although there is no evidence yet in respect of the extent to which the relatively new ESERO project has succeeded in its mission, two encouraging indications should be noted: firstly, the positive and in some cases enthusiastic feedback from the educators;<sup>52</sup> secondly, the rapid increase (within 8 years) of the number of member states that have chosen to collaborate with ESA and allocate resources for the establishment of their own national office. In the near future, it is expected that the ESERO family will welcome 5 new members since Switzerland, Austria, Italy, Spain and Greece have expressed interest in being the next ESA member states to participate in the project.<sup>53</sup>

Through the ESERO project, space not only becomes part of the solution to the issues of low-achieving and early school leaving but it can also encourage more young persons to follow the path of STEM university education. This objective, which is essential for the actualization of the Strategy's "smart growth" priority, is thoroughly discussed in the second chapter of this report (2.2.).

<sup>49</sup> Education. "Inspiring the Future." European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf>>

<sup>50</sup> Schrogl, Kai-Uwe. „The Sky is Not the Limit- Faszination Weltraum für die Jugend.“ Presentation. Space Day 2014. 50 Years of European Co-operation and Innovation in Space

<sup>51</sup> "ESA and Dutch Space Office Join Forces to Bring Space to Schools." 28 May 2013. European Space Agency 11 December 2014 <[http://www.esa.int/Education/Teachers\\_Corner/ESA\\_and\\_Dutch\\_Space\\_Office\\_join\\_forces\\_to\\_bring\\_space\\_to\\_schools](http://www.esa.int/Education/Teachers_Corner/ESA_and_Dutch_Space_Office_join_forces_to_bring_space_to_schools)>

<sup>52</sup> Education. Inspiring the Future." European Space Agency 7 December 2014 <<http://esamultimedia.esa.int/docs/edu/ESA-EdSuccess.pdf>>

<sup>53</sup> Schrogl, Kai-Uwe. „The Sky is Not the Limit- Faszination Weltraum für die Jugend.“ Presentation. Space Day 2014. 50 Years of European Co-operation and Innovation in Space



## 2. Tertiary Education

### 2.1. Space for General Tertiary Education Attainment

#### 2.1.1. The Iron Triangle

Through the headline target, the Strategy calls on EU Member States to address the following 3 challenges: (a) to broaden the access of young Europeans to tertiary education; (b) to reduce the proportion of students who fail to graduate (dropouts); and (c) to improve the quality of higher education and its relevance to the world of work. The last-mentioned challenge is essential for the target because it ensures the long-term attractiveness of higher education.<sup>54</sup>

With regard to widening access and raising completion rates, the European Higher Education Area (EHEA)<sup>55</sup> Ministerial Conference of April 2012 stressed that “the student body entering and graduating from higher education should reflect the diversity of Europe’s populations.” For this purpose, setting out their priorities for action during the period 2012-2015, the EHEA Ministers committed themselves to the inclusion in national educational policies of measures targeting the broader participation of under-represented groups in higher education.<sup>56</sup> In view of that agreement, the EU Council invited the EU Member States, in particular, to adopt national objectives aimed

at increasing the share of such groups among tertiary education students and graduates.<sup>57</sup>

It is to be noted that the communiqué of the EHEA conference does not specify which social groups require particular attention by educational policy-makers. Therefore, the enumeration by the OECD of the factors that should not influence access to and the outcomes of education in an equitable tertiary education system, could be very useful for the identification of disadvantaged groups. According to the OECD, these factors are: socio-economic status, gender, ethnic origin, immigrant status, place of residence, age and disability.<sup>58</sup> By focusing efforts to increase the share of tertiary education graduates on disadvantaged groups, this part of the headline target becomes instrumental for the Strategy’s priority to turn Europe into a more “inclusive” economy (i.e. an economy that delivers economic, social and territorial cohesion and ensures access and opportunities for all).

The need to extend education (at all levels) to a greater share of the population has always brought governments to face the same dilemma: namely the maintenance of the correct balance between access, quality and cost. These three factors are linked in an unbreakable reciprocal relationship, such that any change in one will inevitably impact the others. That is to say, when access increases, costs must also rise to avoid a decrease in quality. The term that is used to describe this inescapable interdependence is the “iron triangle” (Figure 1).<sup>59 60</sup>

<sup>54</sup> European Commission. Thematic Summary: Europe 2020 Target: Tertiary Education Attainment. <[http://ec.europa.eu/europe2020/pdf/themes/28\\_tertiary\\_education\\_02.pdf](http://ec.europa.eu/europe2020/pdf/themes/28_tertiary_education_02.pdf)>.

<sup>55</sup> The EHEA consists of 47 countries (all EU Member States are included), which, together with the European Commission and the consultative members (CoE, UNESCO, ESU, EURASHE, ENQA, Education International and BUSINESSEUROPE) participate in the Bologna Process for the European co-operation in higher education. “How Does the Bologna Process Work?” Bologna Process- European Higher Education Area 18 September 2014 <<http://www.ehea.info/article-details.aspx?ArticleId=5>>.

<sup>56</sup> EHEA Ministerial Conference. Bucharest Communiqué. 26 April 2012.

<sup>57</sup> Council of the EU. 3239th EDUCATION, YOUTH, CULTURE and SPORT Council Meeting. Press Release. Council Conclusions on the Social Dimension of Higher Education. 16-17 May 2013. Brussels: European Union.

<sup>58</sup> OECD. Tertiary Education for the Knowledge Society. Volume 2. Paris: OECD, 2008:14.

<sup>59</sup> Immerwahr, John, Jean Johnson and Paul Gasbarra. “The Iron Triangle: College Presidents Talk about Costs, Access, and Quality.” A Report from the National Center for Public Policy and Higher Education and Public Agenda. October 2008 <[http://www.highereducation.org/reports/iron\\_triangle/IronTriangle.pdf](http://www.highereducation.org/reports/iron_triangle/IronTriangle.pdf)>.

<sup>60</sup> The same access-cost-quality “iron triangle” is observed in healthcare.

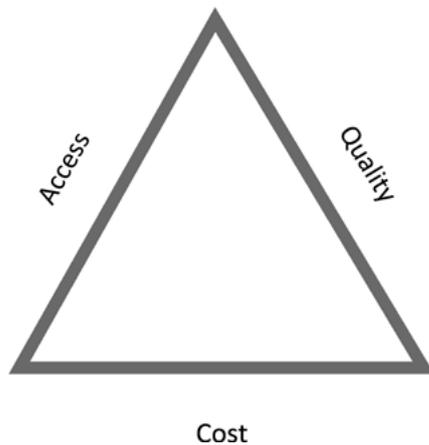


Figure 1: The Iron Triangle.

For the EU Member States, to widen access at the expense of the quality of the European higher education is definitely not an option. According to the Commission's "Agenda for the Modernisation of Europe's Higher Education Systems" (foreseen by the flagship initiative "Youth on the Move") the quantity, which the headline target aims for, is only one of the 5 "key priorities" that the EU and the Member States should set in their tertiary education policies. These priorities are the following: (1) quantity, which consists in widening access and reducing dropouts; (2) quality and relevance of programmes, teaching and teachers; (3) international cooperation and mobility; (4) linking education, research & innovation (knowledge triangle); and (5) targeting funding and tailoring governance.<sup>61</sup> The aforementioned priorities not only supplement the headline target but, by ensuring the maintenance of the prestige and the attractiveness of Europe's tertiary education, are also crucial to the sustainability of the high rates of tertiary educational attainment in Europe. In addition, the Strategy's flagship initiative "Youth on the Move" underlines the importance of high quality learning and teaching at all levels of the educational system while placing special emphasis on the tertiary level.<sup>62</sup>

Consequently a significant increase in funding must be regarded as a necessity. In fact, a substantial funding increase of Europe's tertiary education institutions is indispensable even without the widening of access. The total investment on higher education institutions in

the EU is too low: 1.5% of GDP on average,<sup>63</sup> compared with 2.8% in the U.S., 1.5% in Japan and 1.6% in the Russian Federation. Nevertheless, the picture is much different if we compare the shares of public expenditure in the above-mentioned rates: 1.2% of GDP in the EU countries on average, 1% in the U.S., 0.5% in Japan and 1% in the Russian Federation.<sup>64</sup>

From these data, it can be deduced that Europe might want to seek a considerable increase in the private sector contribution to the funding of its higher education institutions. Although the largest part of private investment comes from the families of students, self-financing by students, and charitable giving, it is surely in the interest of the private sector to invest in the preparation of its future workforce. In the space industry, in particular, existing practices such as the subsidizing of space studies programmes and the provision of grants to talented youngsters for studies related to space could be substantially expanded. Financial help from non-profit organizations could also make a considerable contribution to addressing the issue of under-represented groups.

Nonetheless, whereas the further involvement of enterprises and non-governmental organizations in the financing of education is certainly beneficial, to cover the funding gap of European higher education through the increase in, or introduction of, student contributions (e.g. tuition fees) does not serve the Strategy's aims. An eventual shifting of the financial burden to students could negatively affect the willingness of many young people to pursue tertiary studies. In addition, an eventual decrease in the affordability of tertiary education would most probably exacerbate the under-representation of students from low-income families.<sup>65</sup> Besides it would also affect the under-representation of persons with migration background, since, in almost all Member States, the latter belong to households with considerably lower median incomes than the rest of the population.<sup>66</sup> Thus, although it can be useful under certain conditions (e.g. exemptions for the poor), the expansion of the financial contributions of students has limits

<sup>61</sup> Roy, Simon. "Higher Education within Europe 2020." Presentation. Embracing Modernisation Agenda Workshop 1. Brussels. 25 Feb. 2013.

<sup>62</sup> European Commission. Communication. Youth on the Move. An Initiative to Unleash the Potential of Young People to Achieve Smart, Sustainable and Inclusive Growth in the European Union. COM (2010) 477 final of 15 September 2009. Brussels: European Union.

<sup>63</sup> EU21 average. There were no data available in the OECD survey from the following Member States: Cyprus, Malta, Latvia, Lithuania, Romania, Bulgaria and Croatia.

<sup>64</sup> OECD (2013), Education at a Glance 2013: OECD Indicators, OECD Publishing. <10.1787/eag-2013-en>.

<sup>65</sup> European Commission/EACEA/Eurydice, 2011. Modernisation of Higher Education in Europe: Funding and the Social Dimension. Brussels: Eurydice.

<sup>66</sup> Eurostat. Migrants in Europe. A Statistical Portrait of the First and Second Generation. 2011 Edition. Luxembourg: Publications Office of the European Union, 2011.



set both by the goal of broadening educational attainment and by Strategy's social dimension (inclusive growth).

As for a further increase of public investment in higher education in Europe, the Commission, stressing the significance of education for Europe's competitiveness, suggests that the Member States find ways to protect and promote longer term investment in education, in general, and increase its efficiency, while continuing their progress in fiscal consolidation. This applies to all Member States including those that still face a severe debt crisis. However, even in the EU countries with the greatest fiscal room for manoeuvre, public spending must remain in line with the rules of the Stability and Growth Pact (SGP).<sup>67 68</sup>

All the considerations above underline the complexity of the challenge of keeping a balance between the three factors, especially under the present economic circumstances. Therefore, it is imperative for Europe to take full advantage of a method that relies to a great extent on space infrastructure and has traditionally facilitated or even enabled access to education for many people, namely distance learning. As has been conclusively demonstrated, under certain conditions distance learning is able to reshape the "iron triangle" by widening access and providing low-cost and high-quality education. Furthermore, distance learning has advantages that make it suitable for the needs of under-represented social groups. These advantages are discussed in the following section.

### 2.1.2. The Solution of Distance Education

Distance education (or distance learning) can be defined as the delivery of learning to individuals, who are not physically "on site" to receive it.<sup>69</sup> The communication between learners and teachers needs, therefore, to be mediated by some type of communication technology. The first form of distance education was invented in the middle of the 19th century and was "correspondence education" (per mail). Since then, distance learning has

been transformed more than once following the evolution of communication technologies. In the 1960s, when most governments sought to expand education to the masses, it was thought that the mass media (especially television) could be utilized for that purpose. The implementation of that idea led to a phenomenal expansion of distance education.

A worldwide milestone in the history of distance learning was the establishment of the UK Open University (UKOU). This was an initiative of the Labour government of Prime Minister Harold Wilson, which saw it as a means to addressing the continuing exclusion from higher education of people from lower income backgrounds.<sup>70</sup> The UKOU came into being in 1969 and started to enjoy enormous popularity in the 1970s and 1980s. Also, thanks to the affordability of its educational services, it became the largest university in Great Britain and, finally, by reaching the fifth place out of 100 British universities in independent quality rankings, it proved the capacity of distance education to excel in all three dimensions: cost-access-quality. Subsequently, UKOU's tremendous success encouraged the establishment of numerous similar institutions around the world. Additionally, many conventional educational institutions decided to supplement their face-to-face teaching programmes with distance education.<sup>71</sup>

In the last almost two decades, distance education has entered the third era of its history (after correspondence and broadcasting), that is, the era of the Internet. It is noteworthy that, contrary to broadcasting, which offers only one-way communication, the Internet has enabled frequent interaction between learners and teachers. Thanks to the advantages of Internet and computer-based technologies, the contemporary form of distance learning has gained immense popularity, which is reflected in constantly growing demand for it.<sup>72</sup> In the U.S., for example, the percentage of students taking at least one online course online enrolments in tertiary institutions increased from 9.6% in 2002 to 32% in 2011.<sup>73</sup> Over the

<sup>67</sup> Legally binding pact, according to which the deficit must not exceed 3% of GDP and public debt must not exceed 60% of GDP

<sup>68</sup> European Commission. Communication. Annual Growth Survey 2014 COM (2013) 800 final of 13 November 2013. Brussels: European Union

<sup>69</sup> Raju, P.L.P. and Gupta P.K. "Satellite Based Education and Training in Remote Sensing and Geo-Information: An E-Learning Approach to Meet the Growing Demands in India." International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XXXIX-B6 (2012): 25-29

<sup>70</sup> "The OU Story." The Open University 23 September 2014 <<http://www.open.ac.uk/about/main/strategy/ou-story>>

<sup>71</sup> Kanwar, Asha and John Daniel. "Distance Education and Open Universities." Higher Education - Teaching and Learning in Higher Education (2010): 404-410

<sup>72</sup> Khan, Junaid A., Khan, Salman A. and Reslan H. Al-Abaji. "Prospects of Distance Education in Developing Countries." International Conference on Millennium Dawn in Training and Continuing Education. University of Bahrain, Saudi Arabia 24-26 April 2001

<sup>73</sup> Allen, Elaine I. and Jeff Seaman. "Changing Course: Ten Years of Tracking Online Education in the United States." Babson Research Survey Group. 2013. <<http://www.onlinelearningsurvey.com/reports/changingcourse.pdf>>

course of the 2000's, emerging nations have also extensively used Internet-based distance learning to meet the educational needs of their economies. For instance, in Brazil, the percentage of undergraduate tertiary students in distance education rose from 1.4% in 2002 to 14.6% in 2010.<sup>74</sup> During the same period, in the Russian Federation, the number of students using different forms of distance education not only increased by 50% but it also surpassed the number of face-to-face students.<sup>75</sup>

The steadily increasing demand in many countries for distance education at tertiary level shows the capacity of this educational modality to meeting the needs of several categories of students. This results from characteristics that differentiate it from the conventional "classroom" educational mode. The main characteristics of distance education are the following: (1) flexibility in terms of space; (2) higher flexibility in terms of time;<sup>76</sup> (3) higher affordability. These 3 basic advantages result not only in broader access to tertiary education but enable the participation in higher education of disadvantaged groups and thus reduces their under-representation.

Because of its locational flexibility, distance education provides a solution to students with disabilities, especially mobility impairment, since the latter face issues including physical access and the need for adjustments and support in accessing the classrooms and social spaces of the university.<sup>77</sup> Furthermore, distance education enables access to higher education to citizens living in rural areas.<sup>78</sup> According to Eurostat, the areas with the highest proportion of tertiary students (relative to their number of residents aged 20-24) tend to be capital regions. Bratislava (Slovakia), Prague (the Czech Republic), Vienna (Austria), Bucharest (Romania) are examples of regions with high comparable values (Figure 2). Obviously, this results from the fact that capital regions host many and large tertiary institutions, which offer a wide spectrum of study

fields and therefore attract large numbers of students from other regions. In fact, there are Member States, where the difference between the capital region and the rest of the regions regarding the concentration of tertiary students is extremely high (e.g. Romania).<sup>79</sup>

<sup>74</sup> Sathler, Luciano. "Distance Learning in Brazil." Presentation. Online Educa Berlin. Berlin. 2 December 2011

<sup>75</sup> Zawacki-Richter, Olaf and Anna Kourotchkina. "The Development of Distance Education in the Russian Federation and the Former Soviet Union." *International Review of Research in Open and Distance Learning*. Volume 13, Number 3 (2012): 165-184.

<sup>76</sup> Mason, Robin and Frank Rennie. "Broadband: A Solution for Rural E-Learning?" *International Review of Research in Open and Distance Learning* Volume 5, No 1 (2004): 1-19.

<sup>77</sup> European Commission. Quinn, Jocey. Report: Dropout and Completion in Higher Education in Europe among Students from Under-Represented Groups. Oct. 2013. Brussels: European Union.

<sup>78</sup> "Urban-Rural Typology." 21 February 2014. Eurostat 1.10.2014 <[http://epp.eurostat.ec.europa.eu/statistics\\_explained/index.php/Urban-rural\\_typology](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Urban-rural_typology)>.

<sup>79</sup> „Education Statistics at Regional Level. “ 2 Oct. 2014. Eurostat 16 September 2014 <[http://epp.eurostat.ec.europa.eu/statistics\\_explained/index.php/Education\\_statistics\\_at\\_regional\\_level](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Education_statistics_at_regional_level)>.

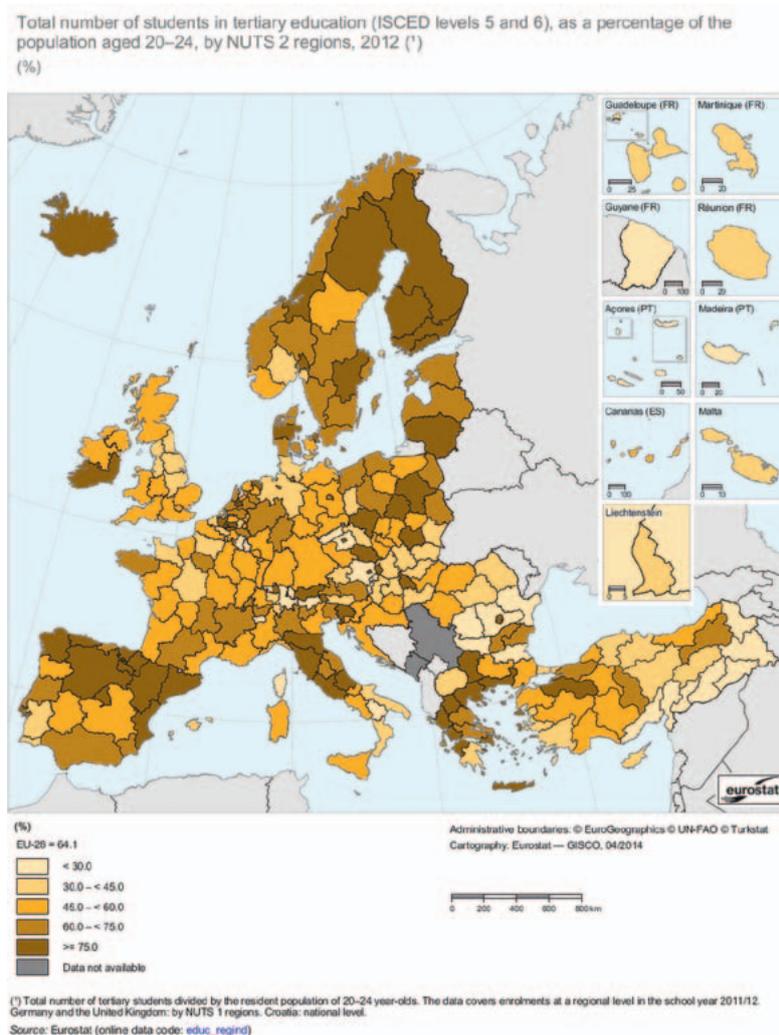


Figure 2: Students in Tertiary Education by Region. Source: "Eurostat Regional Yearbook 2014: Education." <<http://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-HA-14-001-03>>.

As a consequence of the uneven distribution of tertiary institutions, young people living in rural areas, in contrast to those living in urban areas, are in most cases obliged to change their place of residence in order to pursue university studies. For this reason, they could be regarded as a large disadvantaged group. The alternative of distance education can alleviate this inequality to some extent. Besides, taking into account the significance of human capital as a determinant of regional growth,<sup>80</sup> to ensure accessibility to higher education to the populations of all EU regions through distance learning would contribute to the Union's territorial cohesion, which explicitly falls within the scope of the Strategy's "inclusive growth" priority.

Moreover, owing to its ability to eliminate geographical distances, distance learning can be

used as a tool to facilitate student mobility. The promotion thereof is a main line of action of the Strategy's flagship initiative "Youth on the Move". To this end, the flagship initiative clearly calls for the utilization of virtual mobility through distance learning in order to complement physical mobility. It is significant that the Union, through the Erasmus programme, aims not only to expand mobility between European universities but also between European and non-European universities.<sup>81</sup> Non-European mobility is in many cases unaffordable. Distance education can give the opportunity to students to attend courses at foreign universities. Such students might not otherwise participate in an Erasmus exchange semester.

As regards the temporal flexibility of distance education, it can be highly beneficial to cat-

<sup>80</sup> European Commission. REPORT: The Urban and Regional Dimension of Europe 2020. Seventh Progress Report on Economic, Social and Territorial Cohesion. Nov. 2011. Luxembourg: European Union.

<sup>81</sup> European Commission. Communication. Youth on the Move. An Initiative to Unleash the Potential of Young People to Achieve Smart, Sustainable and Inclusive Growth in the European Union. COM (2010) 477 final of 15 September 2009. Brussels: European Union.

egories of students who face time constraints, such as studying mothers or working students. The latter is a very large group, which includes also older students who had missed the opportunity of higher education at a younger age. Time constraints discourage these groups from beginning study programmes, or lead to delay or lack of completion. It is noteworthy that the time flexibility of distance education is relativised by a mix of asynchronous on-line learning and online synchronous sessions. The latter are whole class meetings or small group meetings. Despite introducing time constraints, the synchronous online meetings give users of distance education services the opportunity to engage in spontaneous discussions and gain a stronger sense of connection with their teachers and peers.<sup>82</sup> Thereby, distance education acquires the positive characteristics of face-to-face education, which further improve its quality.

Finally, thanks to the comparatively low-cost of distance learning, the provision thereof by the state to students who satisfy entry requirements cannot be considered to be fiscally burdensome even without tuition fees. Additionally, if there are tuition fees, they are on average lower than those for conventional face-to-face studies. The reduction of the overall cost through the deployment of distance learning consists in (a) savings in the appointment of instructors since more students can participate without an increase in the lecturing hours; (b) in the procurement of the infrastructure, which traditional education requires (e.g. classrooms); (c) and in labour hours for the administration of the courses;<sup>83</sup> (d) a distant learner does need to resettle in a high rent surrounding, which also constitutes a substantial financial burden. The affordability of distance learning makes higher education available to European citizens from lower social strata and, therefore, directly serves the social dimension of tertiary education.<sup>84</sup>

Taking into account numerous studies that have shown that distance learners have equal and in some cases better outcomes and levels of satisfaction from the educational ex-

perience than face-to-face learners,<sup>85</sup> it can be assumed that the implementation of an adequate distance education policy, focusing on matters of accreditation and quality assurance,<sup>86</sup> can be highly cost-effective. This does not only reproduce the "iron triangle" but also transfigures it into an "isosceles triangle", where: cost is reduced; access is broadened; and quality is improved (Figure 3).<sup>87</sup>

<sup>82</sup> Yamagata-Lynch, Lisa C. "Blending Online Asynchronous and Synchronous Learning." *International Review of Research in Open and Distance Learning*. Volume 15, Number 2 (2014): 189-212.

<sup>83</sup> Hjeltnes, Tor Atle, and Börje Hansson. *Cost Effectiveness and Cost Efficiency in E-Learning*. Trondheim: The TISIP Foundation, 2005.

<sup>84</sup> Council of the EU. 3239th EDUCATION, YOUTH, CULTURE and SPORT Council Meeting. Press Release. Council Conclusions on the Social Dimension of Higher Education. 16-17 May 2013. Brussels: European Union.

<sup>85</sup> Abdous, M'hammed, and Miki Yoshimura. "Learner Outcomes and Satisfaction: A Comparison of Live Video-Streamed Instruction, Satellite Broadcast Instruction, and Face-to-Face Instruction." *Computers & Education* 55 (2010): 733-741.

<sup>86</sup> Gokool-Ramdoo, Sushita. "Policy Deficit in Distance Education: A Transactional Distance." *International Review of Research in Open and Distance Learning* Volume 10, Number 4 (2009): 1-21.

<sup>87</sup> cf. Daniel, J.S. *Mega Schools. Technology and Teachers. Achieving Education for All*. New York: Routledge, 2010.

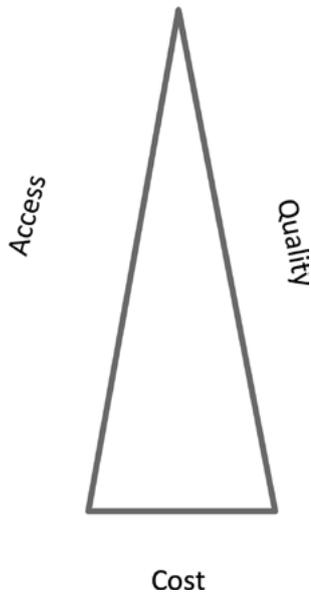


Figure 3: The Iron Triangle Reshaped.

The potential of distance learning as described above seems to be recognized by the EU. Indeed, according to the Lisbon Treaty (Article 165 TFEU), the Union shall actively encourage the development of distance education. It is also noteworthy that the then--Commissioner for Education, Androulla Vassiliou, underlined: "The demand for higher education has never been greater, and will continue to grow. At the same time, there are severe constraints on the capacity of the university system to accommodate the many students who aspire to a higher education. In this situation distance learning institutions are uniquely placed to take care of the educational needs of all students who cannot attend a conventional institution."<sup>88</sup>

Since the modern type of distance learning is online education, a precondition for the exploitation of the possibilities that distance education offers in the digital age is high-speed Internet (broadband). Consequently, also for this purpose, fast connectivity should be guaranteed for all citizens, no matter where they are located.<sup>89</sup> Thus, the educational headline target can be underpinned by the attainment of another measurable target of the Strategy, which is included in the flagship initiative "Digital Agenda", namely the target for "fast

<sup>88</sup> European Commission. Androulla Vassiliou. "The Role of Open and Flexible Education in European Higher Education Systems for 2020 New Models, New Markets, New Media." SPEECH/12/658. EADTU 25th Anniversary Conference. Pafos, Cyprus. 27 September 2012.

<sup>89</sup> Mason, Robin, and Frank Rennie. "Broadband: A Solution for Rural E-Learning?" International Review of Research of Open and Distance Learning Volume 5, Number 1 (2004):1-19.

and ultra-fast Internet access".<sup>90</sup> To this end, the most mature of space applications, namely satellite communications, makes a pivotal contribution.<sup>91</sup>

### 2.1.3. Satellite Communication for Distance Education

Through the flagship initiative the "Digital Agenda", the Strategy stresses the necessity of high-speed Internet services for the Union's economic growth and for the availability of essential digital content and services for its citizens. According to numerous studies, on-line education is among the most significant services that broadband supports.<sup>92</sup> For this and for many other uses, the "Digital Agenda" has called on the Commission and the Member States to ensure the availability of (a) basic broadband to all Europeans by 2013; and, furthermore, that, by the end of the current decade: (b) all Europeans have access to the much higher Internet speeds of more than 30 Mbps (Mbit per second) and (c) 50% or more of European households subscribe to Internet connections above 100 Mbps (Table 1).<sup>93</sup>

The 3 Levels of Broadband Speeds	
Basic	2 Mbps
Fast	30 Mbps
Ultra-Fast	100 Mbps

Table 1. The Levels of Broadband Speeds. Source: European Commission. "Broadband Glossary." 23 Oct. 2014 <<http://ec.europa.eu/digital-agenda/en/broadbandglossary>>

The target of universal basic broadband coverage was achieved on time and satellites made a decisive contribution. By the end of 2012, 99.4% of EU households had basic broadband coverage through terrestrial technologies. 0.6% of EU households (or roughly 3 million citizens) had no other option apart from sat-

<sup>90</sup> European Commission. Communication. A Digital Agenda for Europe. COM (2010) 245 final of 19 May 2010. Brussels: European Union.

<sup>91</sup> "Telecommunications Satellites." 10 December 2012. European Space Agency <[http://www.esa.int/Our\\_Activities/Telecommunications\\_Integrated\\_Applications/Telecommunications\\_satellite](http://www.esa.int/Our_Activities/Telecommunications_Integrated_Applications/Telecommunications_satellite)>.

<sup>92</sup> Mason, Robin, and Frank Rennie. "Broadband: A Solution for Rural E-Learning?" International Review of Research of Open and Distance Learning Volume 5, Number 1 (2004):1-19.

<sup>93</sup> European Commission. Communication. A Digital Agenda for Europe. COM (2010) 245 final of 19 May 2010. Brussels: European Union.

ellite-based connectivity (Table 2).<sup>94</sup> The latter percentage was composed of residents of areas with difficult topographical conditions, which make terrestrial connectivity impractical, or areas with particularly low population density, which makes it economically unviable. Clearly, this economic non-viability results from the fact that unit costs for terrestrial connection increase significantly as population densities drop, because of high fixed investment costs for infrastructure.<sup>95</sup>

For these reasons terrestrial broadband connectivity will never reach the last millions of the European population. As a consequence services such as contemporary tertiary distance education will never be available through terrestrial means to those Europeans who are most in need of them due to their remoteness from institutions located in urban areas.

How we got to 100% basic broadband coverage?	
FIXED (ADSL, VDSL, cable, fibre, copper)	96.1%
MOBILE (2G, 3G, 4G)	99.4%
SATELLITE	100% <sup>99</sup>

Table 2: 100% Basic Broadband Achieved Across Europe. Source: "Broadband Glossary." European Commission 23 Oct. 2014 <<http://ec.europa.eu/digital-agenda/en/broadbandglossary>>

<sup>94</sup> European Commission. Press Release. 100% Basic Broadband Coverage Achieved across Europe – EU Target Achieved Ahead of Schedule. Next Stop Is Fast Broadband for All. IP/13/968 of 17 October 2013. Brussels: European Union.

<sup>95</sup> Eutelsat. Department of International and Institutional Affairs. Anelli S., P. Feltz, P-F. Griffiths and D. Roth. "Satellite's Role in the Penetration of Broadband Connectivity within the European Union." June 2014. Paris: Eutelsat.

<sup>96</sup> 99.97%, more precisely. The few sets of unserved households (0.03%), due to unavailability of satellite broadband, were located in Lithuania, Latvia, Estonia and Iceland (apart from the EU countries, Switzerland, Norway and Iceland were included in the survey). European Commission. REPORT: Broadband Coverage in Europe in 2012. By Point Topic. 2013. Luxembourg: European Union

In contrast to terrestrial technologies, for satellite broadband (i.e. high-speed Internet connection via communication satellites) the costs do not vary according to each area's population density. The reason is that once the space infrastructure is in place, connectivity is eo ipso established. The subscriber, no matter where he or she is located, needs merely to acquire relatively low-cost equipment that is simple to install and use, and pay a flat-rate monthly fee.<sup>97</sup> The average price for the subscriber's equipment (antenna and modem) is currently €350 with basic subscription packages starting from €10 per month.<sup>98</sup> These fees are comparable with (and often better than) the equivalent performance ADSL offers.<sup>99</sup>

With regard to performance, the speed of satellite broadband has increased significantly thanks to a recent R&D achievement of the space sector, namely the emergence of High Throughput Satellites (HTS). This new type of communication satellite is a "game changer" in the niche of Internet access, since it is capable of providing a high-speed service at a competitive price. For instance, since 2011 Europe's first HTS, KA-SAT, which is owned by the satellite operator Eutelsat, has provided an always-on service delivering speeds of up to 20 Mbps downstream and 6 Mbps upstream to users across Europe and the Mediterranean Basin.<sup>100</sup> The monthly fee for this service is €30.<sup>101</sup>

The capacity of satellites such as KA-SAT is useful not only for the uncovered 0.4% of the EU population. It can also provide the solution to the inhabitants of another group of rural areas characterized as "underserved" (Figure 4). Such areas have access to fixed terrestrial broadband, but this is of a limited maximum speed (up to only a few Mbps). The

<sup>97</sup> "SABER- Satellite Technology Crash Course." 27 February 2013. Satellite Broadband for European Regions 21 October 2014 <<http://www.project-saber.eu/cms/documents/file/29-saber-satellite-technology-crash-course?tmpl=component>>

<sup>98</sup> European Commission. Press Release. 100% Basic Broadband Coverage Achieved across Europe – EU Target Achieved Ahead of Schedule. Next Stop Is Fast Broadband for All. IP/13/968 of 17 October 2013. Brussels: European Union

<sup>99</sup> "Broadband for All via Satellite". European Commission 23 October 2014 <<http://ec.europa.eu/digital-agenda/en/broadband-all-satellite>>

<sup>100</sup> "Eutelsat Communications via KA-SAT: Global Communication Solutions for Any Situation." 20 March 2014 Eutelsat 26 October 2014 <<http://www.eutelsat.com/files/contributed/products/pdf/Eutelsat-Broadband.pdf>>

<sup>101</sup> Eutelsat. Department of International and Institutional Affairs. Agnelli S., P. Feltz, P-F. Griffiths and D. Roth. "Satellite's Role in the Penetration of Broadband Connectivity within the European Union." June 2014. Paris: Eutelsat



lessened performance of terrestrial broadband in those areas is the result of the distance between the households and the infrastructure (DSLAM) providing broadband access. However, the price for subscribers is the same as in the urban (over-served) areas.<sup>102</sup> The percentage of both the unserved and the underserved population in Europe ranges from 0.4% to 4% depending on the region.<sup>103</sup>

Unquestionably, lower speed results in proportionally low adequacy of broadband for the provision of online education. In such areas terrestrial broadband does not allow services such as proper television and video-on-demand. The absence thereof presents a considerable difficulty for online education with respect to synchronous (live) and asynchronous (on replay) virtual attendance of classroom activities for learners.<sup>104</sup> Actually, high-speed (and not just basic) broadband is indispensable for the efficient delivery of educational content with audio, graphics and video.<sup>105</sup>

a principle that is at the heart of the “Europe 2020 Strategy”. This objective is undermined if rural distant learners receive an excessively time-consuming downgraded service due to poor connections.<sup>106</sup> Lowered performance can also discourage the residents of underserved areas from subscribing to distance learning programmes. Consequently, by providing them with large bandwidth Internet, which also services overserved areas, this new generation of communication satellites can ensure the ability of distance learning to deliver high-quality higher education to the Union’s outermost regions and thus, support the Strategy’s “inclusive growth” priority.<sup>107</sup>

The technical requirements of modern online education are but one example of the inadequacy of the basic speed level to meet the current needs of European societies. This was recognized by the Strategy, which set “ba-

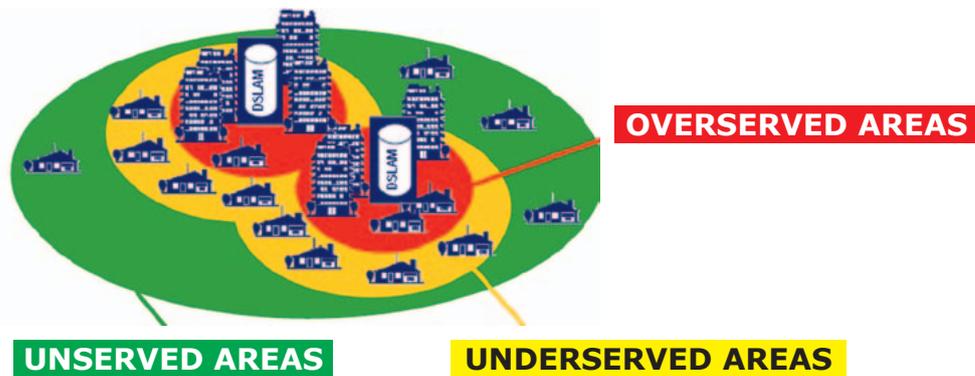


Figure 4: Households Broadband Coverage. Source: „SABER“ 21 Oct. 2014 <<http://www.project-saber.eu/cms/>>

High Throughput Satellites (HTS) provide underserved areas with an alternative to insufficient broadband connectivity delivered by terrestrial means, thus enabling online education. As explained above, distance education is a tool that can substantially contribute to the realization of the Union’s territorial cohesion,

“fast broadband for all” only as an intermediate goal. According to the “Digital Agenda”, broadband coverage has to be guaranteed to all Europeans with speeds gradually increasing up to 30 Mbps and above. In other words, the “fast broadband for all” target must be met by 2020 (Table 1). European satellite manufacturers are currently focusing R&D activities on further increasing bandwidth, which European communication satellites can offer to consumers at a reasonable price. Professional offers already exist but they are not affordable for the larger part of the European population. The goals of the R&D activities, are: (a) 50 Mbps in 2017/2018 (b) 100 Mbps in 2020/22.

<sup>102</sup> “SABER-Satellite Technology Crash Course.” 27 February 2013. Satellite Broadband for European Regions 21 October 2014 <<http://www.project-saber.eu/cms/documents/file/29-saber-satellite-technology-crash-course?tmpl=component>>

<sup>103</sup> Information provided by CSI-Piemonte, the leader of the project SABER

<sup>104</sup> Vázquez-Cano, Esteban, Javier Fombona, and Alberto Fernández. “Virtual Attendance: Analysis of an Audiovisual over IP System for Distance Learning in the Spanish Open University (UNED)” *International Review of Research of Open and Distance Learning* Volume 14, Number 3 (2013):403-426

<sup>105</sup> European Commission. DG Communications Networks, Content & Technology. *The Socio-Economic Impact of Bandwidth. Final Report (2013)* by Analysis Mason Limited and Tech4i2 Limited. Brussels: European Union

<sup>106</sup> Mason, Robin, and Frank Rennie. “Broadband: A Solution for Rural E-Learning?” *International Review of Research of Open and Distance Learning* Volume 5, Number 1 (2004):1-19

<sup>107</sup> European Commission. *Communication. EUROPE 2020. A strategy for smart, sustainable and inclusive growth. COM (2010) 2020 final of 3 March 2010.* Brussels: European Union

If the space industry achieves its first goal, the "Digital Agenda" target for universal fast broadband coverage will also be achieved on time. Thereby, online education will be facilitated. It will become more time-efficient and, as a result, more appealing in all EU regions. An increase in demand can be expected, especially if an effective promotion strategy is undertaken.

In spite of its importance for Europe's targets, R&D work for the improvement of the performance of HTS is not satisfactorily supported by the Union's funding programme for research and innovation, "Horizon 2020". Instead, it is financed by the space industry, national agencies and ESA. The latter contributes also through its ARTES programme (Advanced Research in Telecommunications Systems).<sup>108</sup>

Although it is not involved in the technological development of HTS, the EU has launched and finances, through its 7th Multiannual Financial Framework, the research programme BATS (Broadband Access via Integrated Terrestrial & Satellite Systems), whose mission is to provide an integrated approach for the combination of the advantages of DSL lines, mobile Internet and the next generation of communication satellites. Thanks to this innovative concept, terrestrial and space technology will be combined in order to achieve the best possible outcome for broadband coverage in Europe.<sup>109</sup>

At this point, it should be clarified that the achievement of the 2013 target for universal basic broadband coverage - as well as eventual attainment of the respective 2020 target - will be of no benefit to the overall aim of the "Digital Agenda" and for the Strategy's objectives in general, unless it leads to a substantial increase in broadband adoption by the European population. Irrespective of the technology, there is a vast gap in Europe between the ubiquitous availability of broadband and the number of European households that use it. This needs to be bridged. Specifically, according to the Digital Agenda Scoreboard, in the middle of 2014, six months after the attainment of the "broadband for all" target, there were still up to 6 million EU houses without broadband connectivity.

Considering the under-exploitation of satellite broadband in Europe and in order to help increase its penetration, Eutelsat, a company with a long history in the field of satellite com-

munication, has initiated the SABER (Satellite Broadband for European Regions) project. The main aims of the project, which is supported by both the ESA and the EU, are: (a) to raise awareness in regard to the capacity of satellite broadband to meet the needs of the residents of unserved and underserved areas; and (b) to provide best guidelines for public procurement for EU institutions and regional public authorities.<sup>110</sup> SABER has recommended the adoption of voucher schemes designed at EU or national level and implemented by regional authorities to subsidize connection costs. This method has already proven effective in raising the demand for satellite broadband in European regions such as Piedmont in Italy, Galicia in Spain and Eure-et-Laure in France.<sup>111</sup>

Awareness and incentives such as the subsidy method proposed by SABER can certainly accelerate the transition from coverage to penetration, whereby the reduction of the digital divide can become a reality. Taking up satellite broadband, European citizens living in unserved and underserved areas will acquire the technical means for their unhindered access not only to tertiary distance education but, generally, to knowledge in all possible digital forms. Fast Internet access enables the utilization of freely shareable learning resources, usable at all levels of education.<sup>112</sup> (See also 1.2)

<sup>108</sup> ASD-Eurospace. "An Insight in the Evolution of GEO Satellite Technologies for Broadband Services." Presentation. European Satellite Industry Roadmap. Brussels. 14 March 2014

<sup>109</sup> „BATS Project." 6 Nov. 2014 <[http://www.batsproject.eu/index.php?option=com\\_content&view=article&id=73&Itemid=280](http://www.batsproject.eu/index.php?option=com_content&view=article&id=73&Itemid=280)>.

<sup>110</sup> Eutelsat. Department of International and Institutional Affairs. Agnelli S., P. Feltz, P-F. Griffiths and D. Roth. "Satellite's Role in the Penetration of Broadband Connectivity within the European Union." June 2014. Paris: Eutelsat.

<sup>111</sup> „SABER Calls for Think Global- Act Local Approach to Solving the European Digital Divide." 30 Sept. 2014. Eutelsat 6 Nov. 2014 <<http://www.eutelsat.com/home/news/press-releases/2014/press-list-container/saber-calls-for-think-global-act.html>>.

<sup>112</sup> European Commission. Communication. Opening Up Education: Innovative Teaching and Learning for all Through New Technologies and Open Educational Resources. COM (2013) 2020 final of 25 September 2013. Brussels: European Union.



## 2.2. Space for STEM Tertiary Education Attainment

### 2.2.1. The Importance of the STEM Disciplines

The European Commission defines the term “smart growth” (one of the three priorities of the Europe 2020 Strategy) as developing an economy based on knowledge and innovation.<sup>113</sup> In order to strengthen innovation for the Union’s future (i.e. new ideas and methods able to increase the competitiveness of products and services or to develop new competitive products and services) it is necessary to tackle the Europe 2020 headline target in the R&D area. According to this target, the Union should increase the investment in R&D up to 3% of its GDP. However, since a large percentage of R&D expenditure is spent on research personnel, to increase R&D expenditure a Member State must dispose of a sufficient number of young, skilled graduates, able to work in the R&D sector. Otherwise, the increase of investment in R&D might have no significant result other than a rise in researchers’ wages.

Consequently, it can be inferred that meeting the benchmark of 40% tertiary education attainment of 30-34 year-olds (and this would be another example of the interrelation between the Strategy’s targets) is essential for the headline R&D target to be meaningful. Nevertheless, merely to approach or even to reach this goal does not guarantee important progress towards the “smart growth” objective of the Strategy, as an increase of the number of graduates in the social sciences and humanities does not substantially develop the innovational capacities of the economy.<sup>114</sup> What would really enhance Europe’s potential for innovation is an increase in the number of STEM studies graduates (i.e. science, technology, engineering and mathematics). At this point, it is noteworthy that the European Commission, through the flagship initiative “Innovation Union”, whose purpose is to underpin “smart growth”, clearly requests the Member States to “ensure a sufficient sup-

ply of science, mathematics and engineering graduates”.

In addition, it should be taken into consideration that unemployment rates also vary by field of study. Whereas lower unemployment rates for tertiary education graduates in total, compared to workers with lower level of education, cannot be disputed, not all tertiary-educated groups enjoy this advantage. According to the OECD, in the U.S., for instance, while mechanical engineers enjoy the privilege of low unemployment rates (3.1%), history graduates and philosophy and religious study graduates face higher-than-average unemployment rates (8.6% and 7.8% respectively).<sup>115</sup> As regards the European Union, according to Eurostat, the unemployment rates of STEM workers were much lower than the respective total unemployment rates in every year of the decade 2000-2010 (Figure 5). Apart from the high employability of graduates with this type of skills, such graduates, if in work, earn much higher wages than the non-STEM workforce. Further, as a result of the income that high-tech workers generate (high-tech occupations are predominantly STEM occupations) additional non-high tech jobs are created. More concretely, it has been estimated that the creation of one high-tech job in a region results in 4.3 non-high tech jobs in the same region.<sup>116</sup>

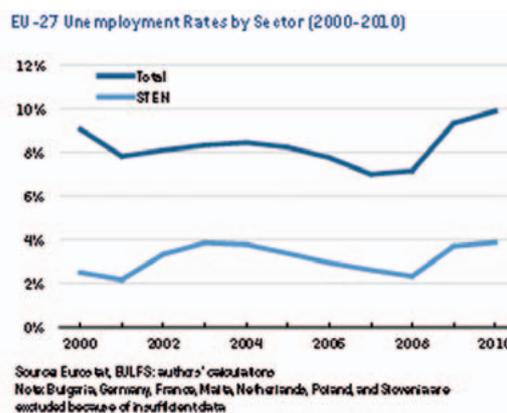


Figure 5: Source: Goos, Marten, and Ian Hathaway, Jozef Konings and Marieke Vandeweyer. “High-Technology Employment in the European Union.” KU Leuven Discussion Paper 41 (2013)

<sup>113</sup> European Commission. Communication. EUROPE 2020. A Strategy for Smart, Sustainable and Inclusive Growth. COM (2010) 2020 final of 3 Mar. 2010. Brussels: European Union

<sup>114</sup> cf. Thum, Anna-Elisabeth, and Felix Roth. “The Key Role of Education in the Europe 2020 Strategy.” CEPS Working Documents. 19 October 2010 <<http://www.ceps.be/book/key-role-education-europe-2020-strategy>>.

<sup>115</sup> OECD (2013), Education at a Glance 2013: OECD Indicators, OECD Publishing. <10.1787/eag-2013-en>

<sup>116</sup> Goos, Marten, and Ian Hathaway, Jozef Konings and Marieke Vandeweyer. “High-Technology Employment in the European Union.” Discussion Paper 41. Ku Leuven (2013)

Consequently, it is questionable whether just raising the proportion of people aged 30-34 with a tertiary degree is the most effective way to create a more skilled workforce, capable of meeting the needs of the economy.<sup>117</sup> In fact, raising the number of STEM graduates constitutes not only a direct contribution to the tertiary educational attainment target of the “Europe 2020 Strategy” but also a considerable indirect contribution to the headline target in the field of employment. Furthermore, because employed STEM workers earn on average a substantially higher income than non-STEM workers, and because income is regarded as one of the most important criteria of job quality, increasing the number of STEM graduates serves the key priority of the “Agenda for New Skills and Jobs” for high-quality jobs.<sup>118</sup>

Over the decade of the Lisbon Strategy (2000-2010), the share of tertiary graduates in Science, Technology, Engineering and Mathematics (STEM) in the EU, aged 20-29, increased from 10.1‰ to 12.5‰. It should be noted that this was a higher growth rate than in the U.S., which, in the period 2000-2010, had an increase from 9.7‰ to 10.7‰ (Table 3).<sup>119</sup> The size of the American STEM workforce fails to meet demand and STEM employers throughout the U.S. report shortages of skilled workers. There appears to be considerable awareness and concern among American decision-makers about this issue.

<b>Tertiary STEM Graduates per thousand population aged 20-29</b>		
	2000	2010
United States	9.7	10.7
EU (27 countries) <sup>121</sup>	10.1	12.5
Belgium	9.7	12.2
Bulgaria	6.6	11.4
Czech Republic	5.5	16.5
Denmark	11.7	16.5
Germany	8.2	14.8
Estonia	7.8	11.3
Ireland	24.2	20.1
Greece	N/A	12.8
Spain	9.9	13.9
France	19.6	20.1
Croatia	N/A	11.6
Italy	5.7	10.4
Cyprus	3.4	5.1
Latvia	7.4	10.7
Lithuania	13.5	18.7
Luxembourg	1.8	3.1
Hungary	4.5	8.3
Malta	3.4	8
Netherlands	5.8	9.2
Austria	7.2	15.5
Poland	6.6	15.8
Portugal	6.3	14.4
Romania	4.5	15.6
Slovenia	8.9	14.8
Slovakia	5.3	18.3
Finland	16	24.2
Sweden	11.6	14
United Kingdom	18.5	18.7

Table 3. Source: European Commission. DG Research & Innovation. Researchers' Report 2013. (Final Report) by Deloitte Consultancy. Brussels: European Union.

<sup>117</sup> cf. Schmid, Günther. New Skills and Jobs in Europe: Pathways towards Full Employment. Luxembourg: Publications Office of the European Union, 2012. p. 73

<sup>118</sup> European Commission. DG Research & Innovation. Researchers' Report 2013. (Final Report) by Deloitte Consultancy. Brussels: European Union

<sup>119</sup> European Commission. DG Research & Innovation. Researchers' Report 2013. (Final Report) by Deloitte Consultancy. Brussels: European Union

<sup>120</sup> Croatia is not included



However, this is no grounds for complacency. Insufficient supply of STEM university graduates has been similarly detected in several EU Member States. For example, in the UK, the Royal Academy of Engineering reported in 2012 that the country needs 100,000 new STEM university graduates every year until 2020 just to meet demand (the annual production of STEM graduates in the UK was only 90,000 at that time including international students who could not obtain work visas at that time whereas some engineers choose jobs in other sectors). In addition, Germany's Deutsche Bank points to a shortage of about 210,000 workers in what they refer to as "MINT disciplines" (i.e. mathematics, computer science, natural sciences and technology). Recruitment difficulties for STEM-related skills have also been reported in several countries including Austria, Hungary and Sweden.<sup>121</sup>

In view of the above, if Europe wants to build an economy based on knowledge and innovation and at the same time approach its goals in the area of employment, it needs to put emphasis on the STEM disciplines. An obstacle in the way of widening participation in STEM study programmes and increasing their completion rates is the attitude of many students that STEM courses are difficult and sometimes unrelated to reality and therefore uninteresting. At the same time, studies have shown that young people are more likely to select a career when they can identify with a role model in that career path.<sup>122</sup> Hence, it can be assumed that the exposure of youth to inspiring career models and activities, which require a solid STEM background, could help overcome this attitudinal obstacle. To this end, the small but iconic space sector can contribute by making this category of studies more attractive and by inspiring young people to become engaged in them.

### 2.2.2. The Need for Motivation

As explained in the previous section, although the Strategy does not include any measurable target regarding the increase in the number of STEM graduates, this is essential for the Strategy's implementation due not only to (a) its contribution to increasing general tertiary educational attainment, but also (b) by helping the efficiency of the targeted rise of public

and private expenditure on R&D, since R&D activities require both sufficient financing and human capital; (c) and by helping increase employment levels thanks to the higher employability (but also wages) of STEM graduates. It is significant that these 3 headline targets (Education, R&D, and Employment) are all instrumental in the realization of the Strategy's priority for "smart growth".<sup>123</sup>

At national and regional level, there are several educational initiatives that focus on STEM tertiary educational attainment, such as the German initiative "MINT Zukunft schaffen" (MINT creates the future). Increasing the proportional share of MINT (meaning STEM in the German speaking area) graduates from approx. 31% in 2005 to 40% in 2015<sup>124</sup> is among the initiative's quantitative and qualitative objectives. Moreover, in 2011 the Department for Employment and Learning of Northern Ireland's launched a ten-year Strategy called "Success through Skills-Transforming Futures". Among others, this sets the strategic goal of increasing the proportion of those qualifying from Northern Ireland Higher Education Institutions with graduate and post-graduate level courses in STEM subjects to 25-30% in 2020 from a baseline of 18% in 2008.<sup>125</sup> To attain these goals, the aforementioned initiatives call for the adoption of several political measures (e.g. improvement of students' preparation at pre-tertiary education level to increase their readiness to start and complete STEM study programmes, extension of university places, scholarships etc.). Through such initiatives, the EU member states and their regions aim at meeting the needs of their economies.

At this point, a fundamental aspect of the target of raising the number of STEM graduates must be identified. It is a feature that is recognized by the above-mentioned initiatives and also characterizes Europe 2020's objective of increasing tertiary educational attainment: the fact that, regardless of whatever action governments take, whether a young person chooses to go to university and the courses he or she chooses to study are decisions that ultimately rest with him or her. Consequently, inspiring youth to follow the path of STEM is crucial, whether at European, national or regional and local level, and it is mainly by

<sup>121</sup> E"Rising STEM's." 13 March 2014. CEDeFoP 15 May 2014 <<http://www.cedefop.europa.eu/FR/articles/22503.aspx>>.

<sup>122</sup> Boy, Guy André; Alexandre Lasslop, and Yasemin Baydaroglu, eds. *TS Report: Space. One Giant Leap for Education*. Strasbourg: International Space University, 2012.

<sup>123</sup> „Europe 2020. Smart Growth. “15 October 2014. European Commission 21 May 2014. <[http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/priorities/smart-growth/index\\_en.htm](http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/priorities/smart-growth/index_en.htm)>.

<sup>124</sup> „MINT. Zukunft Schaffen. Politische Vision 2015.“ 25 May 2014. <<http://www.mintzukunftschaffen.de/politische-vision-2015.html>>.

<sup>125</sup> Department for Employment and Learning. *Success through Skills-Transforming Futures*. 25 May 2011. Belfast: Executive of Northern Ireland.

virtue of their capacity to inspire that space activities may be useful for the required transformation.

The evocativeness of space activities and their potential to attract the interest of younger generations in STEM was recognised by the Communication on the European Space Policy, drafted by the Commission and ESA's Director General, Jean-Jacques Dordain and adopted by the 4th "Space Council"<sup>126</sup> in 2007. In that document, the European Space Policy institutional actors (i.e. EU, ESA and Member States) committed themselves to build further on links between space and the education sector. One such link is the ESERO project (section 1.3 above).<sup>127</sup>

According to the Special Eurobarometer on the "Europeans' Attitudes to Space Activities", the opinion that the inclusion of subjects linked to space activities in educational materials would encourage more students to choose careers in STEM is shared by 7 out of 10 European citizens<sup>128</sup> (Figure 6). More precisely, the Commission's survey documented that 23% of Europeans think that this would definitely be the case; 50% consider it to be very probable; 13% answered that such subjects probably would not encourage more students towards STEM career paths; and only 4% of the European population believes that this would definitely not be the case. In view of these results, it may be predicted that the inclusion of space in educational materials (e.g. through the expansion of the ESERO project) for this purpose would enjoy citizens' approval.

QF8. To what extent, do you think that including subjects linked to space activities in educational materials would encourage more students to choose careers in science, technology, engineering, and mathematics?

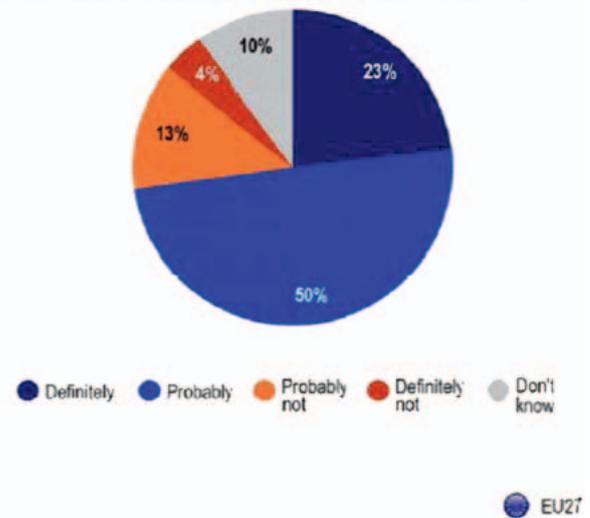


Figure 6: European Commission. Report: European's Attitudes to Space Activities. Special Eurobarometer 403 of January 2014.

Furthermore, the socio-demographic analysis of the responses documented the following: (a) that, in comparison with the other age groups, those aged 15-24 are more likely to think that these subjects would be an effective source of inspiration for pursuing STEM careers; and (b) those who have not completed their studies yet have the highest likelihood of thinking the same (Figure 7). These two findings should be regarded as meaningful for two reasons: firstly, the age group 15-24 is the one that stands before the difficult choice of a career path (at least to a greater extent than the older age groups) and, thus, it is probable that it feels the need for motivation; secondly, those who have not completed their studies yet may also feel the need to be encouraged to graduate, to acquire skills and knowledge and perhaps to certify them through good marks. Considering that, for the attainment of the target, access to tertiary STEM programmes needs to be widened and completion rates of these programmes need to rise, it can be inferred that young people (aged 15-24) and people still studying constitute the primary target groups of a possible strategy for motivation. Consequently, the conclusion may be drawn that of those who should be targeted in such a strategy, 77% and 78% respectively are confident about the capacity of space to inspire them. Besides, it is also a good indication that the higher the educational level of the respondents the higher the percentage of positive responses.

<sup>126</sup> Namely the concomitant meeting of the EU Council of Ministers and the Council of ESA at Ministerial Level.

<sup>127</sup> Commission of the European Communities. Communication. European Space Policy COM (2007) 212 final of 26 April 2007. Brussels: European Union.

<sup>128</sup> European Commission. Report: European's Attitudes to Space Activities. Special Eurobarometer 403 of January 2014.



QF8 To what extent, do you think that including subjects linked to space activities in educational materials would encourage more students to choose careers in science, technology, engineering, and mathematics?

	Total 'Definitely/Probably'	Total 'Probably not/Definitely not'	Don't know
EU27	73%	17%	10%
<b>Sex</b>			
Male	75%	17%	8%
Female	71%	17%	12%
<b>Age</b>			
15-24	77%	17%	6%
25-39	74%	18%	8%
40-54	74%	17%	9%
55 +	71%	15%	14%
<b>Education (End of)</b>			
15-	67%	17%	16%
16-19	73%	17%	10%
20+	77%	17%	6%
Still studying	78%	17%	5%

Figure 7. Source: European Commission. Report: European's Attitudes to Space Activities. Special Eurobarometer 403 of January 2014.

This EU-wide survey demonstrates that the vast majority of Europeans recognize the potential of space for the reduction of the STEM deficit through its inclusion in educational materials. However, this does not exhaust space's full potential regarding this objective. That is to say, inspiration of the young generation is an effect, which occurs not only in the course of scholastic activities, but also through all means of outreach, namely the social and traditional media, space science and technology museums, exhibitions and lectures on space achievements. Regardless of its form, the communication of space can be useful for the Strategy's implementation both because space awareness is needed in order to justify the investment in space applications, which serve the Strategy's targets (e.g. Copernicus for the climate change headline target) and because it can motivate the young generation to acquire the skills that are indispensable for turning Europe into a "smart" economy.<sup>129 130</sup>

### 2.2.3. The Motivational Capacity of Space Exploration

Contrary to the dawn of the Space Age in the 1960's, when progress in scientific exploration of space was catalyzed by the technology race between the Soviet Union and the U.S., in the post-cold war era public spending on space activities is restricted to areas that hold the promise of fulfilling pressing societal demands.<sup>131</sup> To a great extent, these demands fall within the Strategy's scope. It is notable that the Lisbon Treaty, which empowers the Union to draw up a European space policy, distinguishes between the exploration and the exploitation of space (Art. 189 TFEU) as two different components. However, space exploration, which according to the Treaty shall form part of the European space policy, not only widens our horizons but also has various other utilitarian aspects that justify public expenditure on it for the benefit of society. One of the provable societal benefits of space exploration is the inspiration of the youth for pursuing qualifications in STEM.

The potential of space exploration to inspire has been shown by the impact of the most memorable space exploration programme: the American programme for landing a human being on the Moon, the Apollo programme. Apollo was initiated by President Kennedy's historic speech in 1961 and it was operational from 1968 to 1972. During the Apollo programme, the increase in NASA spending was followed by a significant increase in the number of doctorates received in Physical Sciences, Engineering and Mathematical Science in the U.S. After the end of Apollo, the number of doctorates followed a regressive path (Figure 8).<sup>132</sup>

<sup>129</sup> cf. Boy, Guy A, „What Space Can Contribute to Global Science, Technology, Engineering, and Mathematics (STEM) Education.“ IAC-12-E1.6.4.

<sup>130</sup> cf. Denis, Gil, Séverine Klein and Bérengère Gueguen. "Use of Social Networks for Outreach, Education and Training on Space Applications, Know-How and Experience of Planete Sciences Midi-Pyrenees and CNES." Acta Astronautica 94 (2014): 765-775.

<sup>131</sup> cf. Feuerbacher, B.P., and H. Stoewer, eds. Utilization of Space. Today and Tomorrow. Heidelberg: SpringerBerlinHeidelbergNewYork, 2008. p. 11.

<sup>132</sup> Siegfried, W.H, "Space Colonization- Benefits for the World", Space Technology and Applications International Forum, 2003.

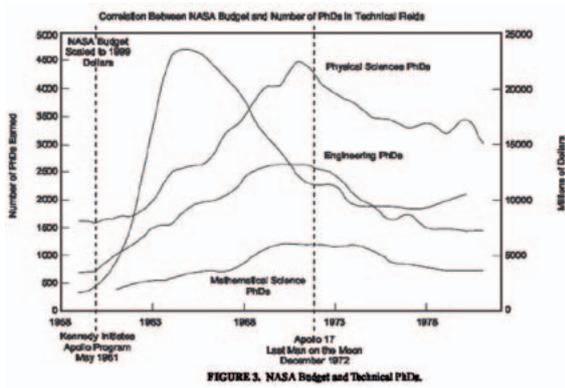


Figure 8. Source: Siegfried, W.H, "Space Colonization - Benefits for the World", Space Technology and Applications International Forum, 2003.

Moreover, a survey carried-out in 2009 among 800 mainly STEM researchers (only 1.4% were social scientists) who had published in the scientific journal "Nature", showed that half of them were inspired by the Apollo programme to become scientists. 18% even answered that they were strongly influenced by Apollo in making that career choice. Additionally, 88.7% of all respondents agreed that human spaceflight benefits society by inspiring youth to study science (Figure 9). Besides, it is noteworthy that, according to the same survey, 83% of European scientists who participated rated their own country's expenditures on human spaceflight as "about right" or "not enough". This is an indication that a possible increase of public expenditure on human spaceflight in Europe, which is far less than the comparable expenditure in the United States, would be welcomed by the European scientific community.<sup>133</sup>

<sup>133</sup> Monastersky, Richard. „Shooting for the Moon.“ 16 June 2014. Nature 15 July 2009 <<http://www.nature.com/news/2009/090715/full/460314a.html>>.

**Did the Apollo missions inspire you in any way to become a scientist?**

Yes, strongly	18.0%
Yes, somewhat	32.0%
Not at all	42.3%
I was already a scientist or on track to become one	7.7%

**To what extent do you agree or disagree that human spaceflight benefits society in the following ways?**

	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree
It enhances national prestige	52.2%	35.3%	8.1%	4.4%
It enhances national security	13.1%	36.9%	29.0%	21.0%
It prompts technological innovation	67.9%	26.5%	4.5%	1.1%
It inspires younger generations to study science	48.2%	40.5%	8.7%	2.7%

Figure 9. Source: Nature, International Weekly Journal of Science.

Doubtlessly, the most inspirational moment in the course of Apollo's implementation was the first lunar landing on 20 July 1969 and the moonwalk of Neil Armstrong and Buzz Aldrin. The moonwalk was televised to a global audience of millions of viewers.<sup>134</sup> Thanks to its wide media coverage, reflecting the interest of the public, space exploration (not only human but also robotic) seems to be the most inspirational type of space activity. Indeed, in Europe, space exploration still enjoys wide media coverage. For instance, the landing of the ESA Huygens probe on the surface of Titan (Saturn's largest moon) in 2005 made the front page in all major newspapers in all ESA Member States. Further, ESA's last astronaut selection (2008/2009) received remarkable attention by the media across Europe.<sup>135</sup>

The European space exploration project, which has perhaps aroused most public attention and excitement, is the "International Rosetta Mission". Rosetta's objective was to study from close proximity the comet 67P/Churyumov-Gerasimenko. After a 10-year journey, on 6 August 2014, Rosetta became the first mission in history to rendezvous with a comet. 3 months later, on 12 November, Rosetta deployed its robotic lander, named Philae, onto the comet's surface. In-situ observation of a comet's surface is also unprecedented. Apart from these historic firsts, the mission is inspiring also thanks to the impressive high-reso-

<sup>134</sup> Norberg, Carol, ed. Human Spaceflight and Exploration. Heidelberg: SpringerHeidelbergNewYork: 2013. p. 27.

<sup>135</sup> Thiele, Gerhard. „Human Space Exploration and European Identity.“ European Identity through Space. Eds. Christoph Venet, Blandina Baranes. Vienna: SpringerWi-enNewYork, 2012: 145-154.



lution stereo images of the comet, which the public is able to view online.<sup>136 137 138</sup>

Although unmanned space exploration projects also receive considerable attention and recognition, human space exploration has an additional advantage, which makes it particularly inspirational to young people. This is the provision of role models. It is remarkable that after their return from the Moon, the three astronauts of the Apollo 11 mission, Armstrong, Aldrin and Collins were treated like Hollywood stars by the media and, just as 8 years earlier, the first and most famous space traveller, Lieutenant Yuri Gagarin became an international celebrity. In the age of the space race, these persons functioned worldwide as role models for a whole generation. Recently, in 2003, the enthusiastic reaction of Chinese society to the spaceflight of Yang Liwei, China's first taikonaut, who also became a hero in his nation,<sup>139</sup> indicates that conditions have not changed that much. Thus, we can anticipate that a human mission for exploration of either the Moon or Mars will produce global public figures with similarly high popularity and recognition, who might have a significant impact on the educational and occupational choices of many young persons.

At this point, it is necessary to explain the term "role model". What makes a person a role model is the act of identification by other individuals; namely, that the former represents a goal, which the latter would like to attain; individuals want to enhance their similarity, to "be like" the role model, and this is because the role model is, in some way, appealing to them. It is also noteworthy that the process of identification does not require interaction between the individual(s) and the role model. That is to say, the role model might be people with whom the individual(s) may have infrequent or no contact at all, as is the case with celebrities, who serve as distant role models.<sup>145</sup>

According to this definition, if an astronaut functions as a role model for young individuals, the process of identification will motivate the latter to acquire similar attributes such as skills. Astronauts dispose of a strong STEM background. The last astronaut selection procedure, for example, which ESA initiated in order to meet its commitments to the ISS programme, required from all applicants to possess a university degree in natural science, engineering or medicine, and be either pilot or have at least 3 years of relevant postgraduate experience. Likewise, NASA requires of all astronaut candidates, regardless of non-piloting or piloting background, to hold at least a Bachelor's degree in engineering, biological science, physical science or mathematics.<sup>140</sup> Consequently, astronauts constitute a professional group of STEM graduates and, thanks to their conspicuousness; they are arguably the most suitable group with such a background to function as distant role models for young people.

A decisive variable in role model selection is similarity – across a variety of dimensions such as gender, nationality, race or migration background.<sup>141</sup> It is more likely for an individual to identify with a public figure with whom he or she shares common traits. With regard to nationality, for example, it has been observed that, if an astronaut from a European country participates in an ESA mission, the news coverage about the mission is very broad in his country, whereas in other ESA Member States the mission usually receives hardly more than a short mention.<sup>142</sup> Thanks to the greater publicity and interest, it is much more likely for an astronaut to become a role model for young people of his or her country. Hence, it is sensible that the European Astronaut Centre (EAC) considers national diversity of European astronauts, where there appears to be a deficit, very consciously in the future. For instance, whereas there have been 11 German astronauts, who have participated in 14 missions in total (the most recent being the "Blue Dot" mission of Alexander Gerst), there has been no astronaut yet, for example, of Irish, Greek,

<sup>136</sup> „Europe's Comet Chaser.“ 16 Jan. 2014. European Space Agency 9 Nov. 2014 <[http://www.esa.int/Our\\_Activities/Space\\_Science/Rosetta/Europe\\_s\\_comet\\_chaser](http://www.esa.int/Our_Activities/Space_Science/Rosetta/Europe_s_comet_chaser)>.

<sup>137</sup> „Rosetta's Frequently Asked Questions.“ European Space Agency 9 November 2014 <[http://www.esa.int/Our\\_Activities/Space\\_Science/Rosetta/Frequently\\_asked\\_questions](http://www.esa.int/Our_Activities/Space_Science/Rosetta/Frequently_asked_questions)>.

<sup>138</sup> „Rosetta to Deploy Lander on 12 November.“ 26 Sept. 2014 European Space Agency 9 November 2014 [http://www.esa.int/Our\\_Activities/Space\\_Science/Rosetta/Rosetta\\_to\\_deploy\\_lander\\_on\\_12\\_November](http://www.esa.int/Our_Activities/Space_Science/Rosetta/Rosetta_to_deploy_lander_on_12_November).

<sup>139</sup> Hansen, James R. "The Taikonaut as Icon: the Cultural and Political Significance of Yang Liwei, China's first Space Traveler." *Societal Impact of Spaceflight*. Eds. Steven J. Dick and Roger D. Launius. Washington: NASA, 2007:103-117

<sup>140</sup> Steimle, Hansulrich, and Carol Norberg. „Astronaut Selection and Training.“ *Human Spaceflight and Exploration*. Heidelberg: SpringerHeidelbergNewYork: 2013: 255-294.

<sup>141</sup> cf. Gibson, E. Donald. "Role Models in Career Development: New Directions for Theory and Research." *Journal of Vocational Behavior* 65 (2004): 134-156

<sup>142</sup> Gibson, E. Donald. "Role Models in Career Development: New Directions for Theory and Research." *Journal of Vocational Behavior* 65 (2004): 134-156

Norwegian or Portuguese nationality, let alone from the new ESA Member States.<sup>143</sup>

The key function of similarity in role model selection underscores the significance of the lack of potential role models for groups that are under-represented among STEM graduates, such as women. In fact, people rarely identify with people who do not match with them in terms of gender. That being so, the space sector could contribute to increasing the availability of potential role models for under-represented groups by increasing the diversity of its personnel and of astronauts in particular. Thereby, young people belonging to disadvantaged groups (such as migrants) could be motivated to acquire those skills, which will substantially increase their chances of upward social mobility.

#### 2.2.4. Role Models to Motivate Women

Women already attained Europe 2020's headline target in tertiary education in 2012, as 39.9% of women aged 30 to 34 from the EU28 had a degree in that year, compared with 31.5% of men (Table 4). Nonetheless, the female gender remains severely under-represented among STEM tertiary graduates with the exception of life sciences, where women comprise the majority. Specifically, in 2011, 40.8% of all graduates in science, mathematics and computing, and only 26.6% in engineering, were women (Table 5).

<b>Tertiary Educational Attainment, 2012 (% of women and % of men aged 30 to 34)</b>		
	Women	Men
EU (28 countries)	39.9	31.5
Belgium	50.7	37.1
Bulgaria	33.6	20.5
Czech Republic	29.1	22.4
Denmark	52.6	33.7
Germany	32.9	31
Estonia	50.4	28.1
Ireland	57.9	44
Greece	34.2	27.6
Spain	45.3	35
France	48.6	38.5
Croatia	28.8	19.4
Italy	26.3	17.2
Cyprus	55.5	43.6
Latvia	48.1	26.2
Lithuania	56.7	40.3
Luxembourg	48.9	50.4
Hungary	35.5	24.7
Malta	24	20.7
Netherlands	44.6	39.8
Austria	26.6	26
Poland	46.5	31.9
Portugal	30.1	24.3
Romania	23.2	20.5
Slovenia	49.6	29.5
Slovakia	28.2	19.4
Finland	55.4	36.7
Sweden	53.7	42.4
United Kingdom	50.2	44

Table 4. Source: EUROSTAT. News Release. 8 March 2014: International Women's Day. In 2012, 40% of Young Women Had Completed Tertiary Education Compared with 32% of Men. News Release 36/2014. 7 March 2014

<sup>143</sup> „Deutsche Astonauten.“ 17 Mar. 2014. Deutsches Zentrum für Luft- und Raumfahrt 22 June 2014 <[http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10366/739\\_read-466/#gallery/488](http://www.dlr.de/dlr/desktopdefault.aspx/tabid-10366/739_read-466/#gallery/488)>



<b>Female tertiary education graduates in Science &amp; Technology, 2011</b>		
	Science, Mathematics & Computing	Engineering
EU (28 countries)	40.8	26.6
Belgium	30.1	21.4
Bulgaria	51	33.4
Czech Republic	39.4	26.9
Denmark	36.9	38.7
Germany	43.6	18.2
Estonia	45.4	31.1
Ireland	40.4	16.9
Greece	46.7	32.7
Spain	36.2	27.2
France	36.2	25.5
Croatia	52.6	28.1
Italy	53.9	33
Cyprus	46	50.4
Latvia	35.3	25.8
Lithuania	39.8	23.2
Luxembourg	33.6	22.2
Hungary	33.3	22.9
Malta	50.7	29.2
Netherlands	25.2	20
Austria	35.4	19.6
Poland	44.8	33.9
Portugal	55.1	31.2
Romania	60.7	35.4
Slovenia	39.9	24.4
Slovakia	42.5	30.5
Finland	44.7	22.4
Sweden	40	29.7
United Kingdom	36.7	21.4

Table 5. EUROSTAT.

The scarcity of women in these fields concerns the Strategy for the following reasons. Firstly, the flagship initiative "Innovation Union" requests a sufficient supply of highly qualified workers able to follow research and innovation careers, underlining the issue that too few women are taking science to an advanced

level.<sup>144</sup> Indeed, the under-representation of women among science and technology graduates is replicated in the proportion of women among PhD graduates in the respective fields; in 2010, women constituted 40% of PhD graduates in science, mathematics and computing and only 26% in engineering. In order to achieve "smart growth" the potential of women for scientific careers needs to be unleashed. Secondly, the acquisition by more women of STEM educations, which results in higher employability, would increase the female employment rate (58.5% in the EU28 in 2012). As women form the major part of the European population, to increase their employment would contribute to the Strategy's target in the area of employment.<sup>145</sup> Thirdly, considering that the STEM study fields are generally those offering more rewarding and stable opportunities,<sup>146</sup> increasing the share of women in these study fields would contribute to the attainment of 2 gender-specific goals of the "Agenda for new Skills and Jobs", namely (a) the reduction of the gender pay-gap (16.4% in the EU28 in 2012) and (b) the improvement of employment security for women.<sup>147</sup> Fourthly, since the gender income gap leads to higher rates of poverty in the female population and the risk of poverty is particularly high for single mothers, acquisition by more women of the skills that promise higher employability and wages, could help the Europe 2020's fifth headline target, i.e. to lift at least 20 million people out of poverty and social exclusion.

Therefore, and since it has been proven that among the factors which lie behind this gender disparity, are (a) gender stereotypes and (b) the lack of role models for women, the space sector could contribute to the implementation of the Strategy also by helping reduce these two factors. Gender stereotypes are defined as simplified perceptions of male and female characteristics. According to these perceptions, talent for craftsmanship, interest in technical issues but also analytical competences are male characteristics. Engineering is

<sup>144</sup> European Commission. Communication. Europe 2020 Flagship Initiative Innovation Union. COM (2010) 546 final of 6 October 2010. Brussels: European Union.

<sup>145</sup> Eurostat. News Release. 8 March 2014: International Women's Day. In 2012, 40% of Young Women Had Completed Tertiary Education Compared with 32% of Men. News Release 36/2014. 7 March 2014.

<sup>146</sup> European Commission. DG Research & Innovation. She Figures 2012. Gender in Research and Innovation. Statistics and Indicators. Brussels: European Union.

<sup>147</sup> cf. Schmid, Günther. New Skills and Jobs in Europe: Pathways towards Full Employment. Luxembourg: Publications Office of the European Union, 2012.

hence deemed to be male in nature and tends not to be a woman's first choice.<sup>148</sup>

Because of the negative impact of stereotypes, as well as due to their double burden through domestic labour, there are, unfortunately, few successful female scientists and engineers. In addition, those that do exist are rarely visible in public life so that they could serve as role models for young women. The shortage of role models able to dissolve gender stereotypes and inspire women is partly responsible for the reproduction of gender segregation in STEM from one generation to the next.<sup>149</sup> Human spaceflight, since the flight of the first woman in space, the Soviet cosmonaut Valentina Tereshkova in 16 June 1963, has sent 57 women into space; "all of them effective role models for thousands of women throughout the world," as the past Director of the United Nations Office for Outer Space Affairs (UNOOSA), Ms. Mazlan Othman, has stated.<sup>150</sup> In addition, it has been observed that the more active female space travellers are in the outreach of space the greater their positive influence on young women. Japanese astronaut Chiaki Mukai's (first Japanese woman in space) outreach activities, for example, demonstrate how STEM can be promoted to a large number of people in our era.<sup>151</sup>

Nevertheless, since the beginning of the space age, women have been under-represented in human spaceflight in the extreme. In fact, female crewmembers comprise only 10.6% of the individuals who have flown in space (57 out of 539).<sup>152</sup> It might be noted also that, unfortunately, Jules Verne's classical works "From the Earth to the Moon" and "Around the Moon" were prophetic also for depicting space travel as an adventure where women have no place at all. This is undoubtedly an issue that needs to be addressed. Considering that a very significant part not only of the EU but also of the Council of Europe acquis is related to gender equality, allowing us to re-

gard the latter as one of the major European values and achievements of the European integration process, the European Space Agency should enhance its gender mainstreaming<sup>153</sup> in astronaut selection procedures and, if possible, distinguish itself among the world's space agencies in this area. In any case, it is encouraging that among the six astronauts designated through ESA's last selection procedure, there is the Italian Samantha Cristoforetti, who, in November 2014, will become ESA's second female astronaut in space (the first being Claudie Haigneré, who flew for ESA in 2001, after having flown in 1996 as a Centre National d'Etudes Spatiales (French Space Agency) cosmonaute).<sup>154</sup>

Apart from astronauts, women who hold positions with high visibility in the space sector could also have a positive influence on many other women's academic choices. The impact of executives such as Pascale Sourisse, former CEO of Thales Alenia Space, and Magali Vaisiere, Director of telecommunications of ESA, should not be underestimated and both the former and the present Director of the Office on Outer Space of the UN, Ms. Mazlan Othman and Ms. Simonetta di Pippo, respectively, constitute powerful examples. Ms. di Pippo is (together with the aerospace engineer Claudia Kessler) co-founder of the organisation "Women in Aerospace Europe" (WIA Europe), part of a global network of WIA's. Attracting more women to the aerospace sector is one of the goals of WIA.<sup>155</sup>

<sup>148</sup> cf. Suter, Christian. "Trends in Gender Segregation by Field of Work in Higher Education." *Women in Scientific Careers. Unleashing the Potential*. Paris: OECD Publications, 2006. 95-104.

<sup>149</sup> cf. Xie, Yu. "Theories into Gender Segregation in Scientific Careers." *Women in Scientific Careers. Unleashing the Potential*. Paris: OECD Publications, 2006. 105-109.

<sup>150</sup> "UN Celebrates 50 Years of Invaluable Contributions by Women to Human Space Flight." 13 June 2013. UN News Centre 2008 <<http://www.un.org/apps/news/story.asp?NewsID=45172&Cr=outer%2Bspace&Cr1=#.U8FooS3mS73>>.

<sup>151</sup> Boy, Guy André; Alexandre Lasslop, and Yasemin Baydaroglu, eds. *TS Report: Space. One Giant Leap for Education*. Strasbourg: International Space University, 2012.

<sup>152</sup> Clément, Gilles, and Bukley, Angelia P. "Human Space Exploration - From Surviving to Performing." *Acta Astronautica* 100 (2014): 101-106.

<sup>153</sup> The Council of Europe has defined the term as "the (re) organisation, improvement, development and evaluation of policy processes, so that a gender equality perspective is incorporated in all policies, at all levels and at all stages, by the actors normally involved in policymaking."

<sup>154</sup> "European Women in Space." 16 June 2013. European Space Agency 14 July 2014 <[http://www.esa.int/About\\_Us/Welcome\\_to\\_ESA/ESA\\_history/50\\_years\\_of\\_humans\\_in\\_space/European\\_women\\_in\\_space](http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/50_years_of_humans_in_space/European_women_in_space)>.

<sup>155</sup> "WIA Global." WIA Europe 21 September 2014



## 2.3. Space Education for the Quality and Relevance of Tertiary Education

As noted at the beginning of this report, the Union's ambitions in tertiary education are not exhausted by a rise in the number of graduates. Neither would they be fulfilled by a mere increase in the proportion of STEM graduates. Instead, they include improvement in the quality of human capital development in Europe's tertiary institutions and in its responsiveness to the needs of the economy. By achieving this, the position of the European higher education institutions in global university rankings can also be improved. For this reason, the launch by the Commission of an "Agenda for the Modernisation of Europe's Higher Education Systems", to supplement the part of the headline target referring to tertiary education, was included in the Strategy's flagship initiative "Youth on the Move".<sup>156</sup>

According to the agenda, Europe's transformation into a "smart economy" requires a workforce disposing of the following mix of skills: (a) a solid understanding of the chosen field; (b) e-skills for the digital era; (c) transversal competences (i.e. competences that have been learned in one context to master a special situation/problem and can be transferred to another context<sup>157</sup>).<sup>158</sup>

With regard to the in-depth understanding of STEM disciplines, the plethora of hands-on activities for university students, offered by the space sector, can have a favourable effect. Student-made satellites such as the "CubeSats" project are a case in point. "CubeSats" are satellites of small size developed by aerospace students. The project demands the combination and application of multidisciplinary academic knowledge and provides students with experience in designing, manufacturing, testing and operating a real spacecraft. Indeed, contrary to the "CanSats", which do not fly above the atmosphere, "CubeSats" are developed to be launched into space and, subsequently, to be operated either from universities or from radio amateur ground stations.<sup>159</sup>

The first 7 "CubeSats" sponsored by ESA were built by teams of 7 universities from 6 ESA Member States and were launched by a "Vega" launcher in February 2012. The success of that initiative encouraged ESA to repeat it.<sup>160</sup> Projects for the development of real satellites in an educational context are carried out in Europe also at national level. The Italian University "La Sapienza" has a quite long tradition with the "Unisat" project. Within the framework of this project, post-graduate students and Ph.D. candidates are involved, every second year, in the design, development and orbiting of university satellites. Since 2000, the programme steadily instils enthusiasm to the participants and is considered to have important educational results.<sup>161</sup>

These training activities help the development of what is called transversal or transferable skills. It is true that due to the pace of technical evolution, the knowledge and skills that an individual accumulates over the course of his studies rapidly become obsolete. Therefore, the significance of space-based hands-on activities such as the aforementioned consists in their contribution to the development of competences, the utility of which remains despite technology's inevitable obsolescence. These are also the skills that can prepare young graduates for varied and unpredictable career paths. The high-level group of experts established by the Commission to analyse the key topics for the modernization of higher education has identified some of those competences: (a) complex thinking, which allows

<sup>156</sup> European Commission. Communication. Youth on the Move. An Initiative to Unleash the Potential of Young People to Achieve Smart, Sustainable and Inclusive Growth in the European Union. COM (2010) 477 final of 15 September 2009. Brussels: European Union

<sup>157</sup> "EU Skills Panorama- Glossary." European Commission 11 November 2014 <<http://euskills Panorama.cedefop.europa.eu/Glossary/>>

<sup>158</sup> European Commission. Communication. Supporting Growth and Jobs- An Agenda for the Modernisation of Europe's Higher Education Systems. COM (2011) 567 final of 20 September 2011. Brussels: European Union

<sup>159</sup> "Cubesats." European Space Agency 14 December 2014 <<http://www.esa.int/Education/CubeSats>>

<sup>160</sup> "Towards a New Educational Cubesat Initiative." 1 Aug. 2012 European Space Agency 14 November 2014 <[http://www.esa.int/Education/Towards\\_a\\_new\\_educational\\_CubeSat\\_initiative](http://www.esa.int/Education/Towards_a_new_educational_CubeSat_initiative)>

<sup>161</sup> Graziani, Filippo, Fabrizio Piergentili and Fabio Santoni. "A Space Standards Application to University-Class Microsatellites: The UNISAT experience." *Acta Astronautica* 66 (2010): 1534-1543

problem solving and experiential learning; (b) social skills and participatory learning (all the above activities require team work) (c) personal shaping of knowledge, which requires an internal drive for knowledge and reflection.<sup>162</sup>

In parallel with the hands-on activities for the production of space technology, ESA's initiatives, "Drop your Thesis" and "Fly your Thesis" along with the programme "Spin your Thesis" provide a contribution to both education and research. The first two give the opportunity to students to perform scientific or technological research in conditions of microgravity,<sup>163</sup> while "Spin your Thesis" allows the conduct of academic research under hypergravity (gravity exceeding that of the Earth's surface) conditions. For the "Spin your Thesis" programme ESA puts at the disposal of researchers its "Large Diameter Centrifuge" at ESTEC. This instrument enables the conduct of experiments in a wide range of scientific fields including: biology, biochemistry, microbiology, opto-physics, physics, material and fluid sciences, geology and plasma physics.<sup>164</sup> Apart from providing high quality research training, these projects enable the production of scientific results that would otherwise be impossible.

Apart from ESA, Europe's national space agencies also have similar projects supporting research and research training. Additionally, collaborations between agencies for educational purposes are frequent. The "Rexus and Bexus" programme, a cooperation between ESA, the German Aerospace Centre (DLR) and the Swedish National Space Board (SNSB), which allows student experiments to be flown on sounding rockets and atmospheric balloons, provides a pertinent example.

These activities bring university communities closer to high-tech centres such as ESTEC. The agenda for the modernisation of Europe's higher education places special emphasis on such rapprochements, which, basically, constitute links between education and research (two of the three sides of the "knowledge triangle") for the benefit of both. The "knowledge triangle" (Figure 10) is a concept that highlights the mutual benefits that can be derived through the development of stronger links between (a) higher education; (b) research and technology; (c) business.

While being a field of R&D par excellence, the space sector also represents the triangle's third dimension since it employs highly skilled graduates, mainly from STEM departments. Thus the interaction between business and higher education institutions could help the latter adapt their programmes to the market's needs and thereby improve the employability of their graduates and better support, at the same time, Europe's "smart" economic growth.<sup>165</sup>

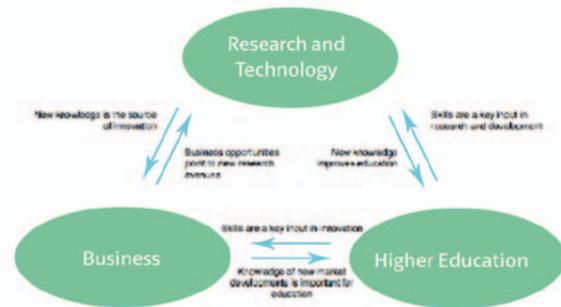


Figure 10: The Knowledge Triangle. Source: EIT. (Reference Nr. 165)

<sup>162</sup> European Commission. Report to the European Commission on Improving the Quality of Teaching and Learning in Europe's Higher Education Institutions. Luxembourg: Publication Office of the European Union, 2013

<sup>163</sup> "About Drop Your Thesis!" European Space Agency 14 December 2014 <[http://www.esa.int/Education/About\\_Drop\\_Your\\_Thesis](http://www.esa.int/Education/About_Drop_Your_Thesis)>

<sup>164</sup> "Spin Your Thesis! Programme." European Space Agency 14 December 2014 <[http://www.esa.int/Education/Spin\\_Your\\_Thesis!\\_programme](http://www.esa.int/Education/Spin_Your_Thesis!_programme)>

<sup>165</sup> European Institute of Innovation and Technology. Catalysing Innovation in the Knowledge Triangle. Practices from the EIT Knowledge and Innovation Communities. Publication prepared by the Technopolis Group.



# Conclusions/Recommendations

Before presenting the final conclusions that can be drawn from the observations above, it should be stressed that these show only a small part of the various contributions that space can make to the realization of the particularly wide-ranging “Europe 2020” growth strategy, as they cover only the policy area of Education. The report does not cover, for instance, the potential of the EU flagship programme Copernicus to underpin the environmental goals included in the Strategy (and also those goals that will be included in its successor for the decade 2020-2030), and does not provide information on the contribution that both flagship programmes, Galileo and Copernicus, make to Europe’s economic growth. Nevertheless, the impact that educational policy can have on other goals included in the Strategy in regard to employment, research and innovation, and social inclusion have been taken into consideration so that the positive input that space can have via the field of education on those policy areas is also demonstrated. In addition, the most direct accomplishment of space in regard to the implementation of the Strategy, namely, the universal provision of broadband, has been covered.

Also, it is clear that this report does not reveal all the possible educational benefits that can be derived from space. Education within the framework of “Europe 2020” is rather seen as an instrument that can improve Europe’s future competitiveness by producing human capital. Education has, in fact, a much wider scope, where space can also play a role. The inclusion in the educational process of space missions and space images can have a positive influence on the way humanity sees the planet and itself. Space can inspire new world-views. Common European space missions like Rosetta can also contribute to the emergence of a European identity. These are all important aspects that did not fall within the scope of this study.

The basic conclusions and recommendations that can be drawn from this study with respect to the Utilisation of the Potential of Space for the Implementation of “Europe 2020” are the following:

- There is a lack of awareness regarding available space educational resources and hands-on activities. The awareness of educators could contribute to improvement of the attractiveness and effectiveness

of instruction in STEM disciplines without additional financial burden.

- The utilization of space for the benefit of primary and secondary STEM education is supported by the ESERO project. The participation of more member states is recommended.
- Faster broadband leads to better online services. Considering the multiple social and economic benefits of high speed broadband, and its enabling function, it is recommended that the Commission further supports R&D activities in satellite communication for this purpose. Satellite Communication has proven itself to be necessary for the “Digital Agenda” target of 100% broadband coverage.
- Modern Distance Education requires high-speed broadband.
- Distance Education is a very cost-effective tool for the increase of tertiary educational attainment.
- Greater visibility of space activities would motivate more young people to follow STEM studies.
- The function of astronauts as role models should be increasingly considered in their selection process. Greater visibility of astronauts would also motivate more youth to choose STEM.
- A larger number of women in high positions in the space sector would encourage women to follow the path of STEM.
- The intensification of the interaction of higher education institutions, space research centres and the space industry would enhance the quality of STEM education at tertiary level and help the employability of graduates.

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Panos Mastorakis graduated from the Department of Communication and Media Studies of the National and Kapodistrian University of Athens in 2009. In 2012, he finished a Master of European Studies at the University of Vienna. The title of his master thesis was: 'European Space Agency: From the Cold War's Margins to an Era of Multipolarity'. As a research

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