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Building a Competence Ecosystem for the Future Space Workforce: International Master Programmes in Northern Sweden's Strategy, Practises and Recommendations

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Introduction

In recent years, the global labor market's requirements have changed significantly. There is a high demand for graduate and postgraduate students who possess excellent subject knowledge, a thorough comprehension of contemporary working practices, technical and higher-order thinking, engineering intuition, and problem-solving abilities. In a typical international workplace, they should also possess professional skills like strong communication and teamwork abilities. Lessons learned and best practices from the international Master Program in Spacecraft Design and the Joint Master Program in Space Science and Technology – SpaceMaster at Lule University of Technology in northern Sweden are discussed in this review, as are educational strategies like student-oriented teaching, project-based learning with its applicability to a "real-world" setting, active learning techniques, the development of entrepreneurial skills, and the advantages of a multidisciplinary study environment. For students of science and engineering, the significance of complementarity between formal, informal, and non-formal learning methods has been specifically emphasized. It is acknowledged that a key success factor for professional training is connections to the workplace through systematic industry involvement in the education, such as an External Advisory Board, shared services and facilities, joint projects, and supervision of Master's and PhD students. The conceptual framework for a Competence Ecosystem for fostering a new generation of space scientists and engineers is a structural combination of cutting-edge pedagogical tools, strategic partnerships with industry, business entities, academic partners, and cutting-edge multidisciplinary labs [1].

With its Space Campus in Kiruna, Lule University of Technology (LTU) is Sweden's northernmost university. The town of Kiruna, 140 kilometers north of the Arctic Circle, has been closely associated with space and atmospheric research in northern Sweden. The town is additionally notable for its iron metal mine LKAB and the widely popular Jukkasjärvi Icehotel. With many years of education, research, and business in the Arctic, the university has a strong Arctic profile in the fields of civil and energy engineering, mining- and natural resources engineering, medical and health sciences, atmospheric and space sciences, and space technology. In order to effectively address current and future global challenges as well as to ensure a sustainable growth of Arctic economic activities, where the role and significance of space activities have been specifically outlined by the European Council in November 2019, research and development projects are carried out in interdisciplinary constellations [2].

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Description

Regulations governing higher education and research in Sweden are established by the Ministry of Education and Research. The national universities' goals are to conduct research and development, collaborate with the communities that surround them, and provide education that is founded on solid academic foundations and demonstrated experience. Universities are authorized to issue general qualifications in the first, second, and third cycles. The Swedish National Agency for Higher Education oversees program quality and grants universities permission to award specific qualifications. As a result, the government oversees the accreditation of educational programs in the nation. These laws apply to LTU because it is a public institution [3].

The 300 ECTS, five-year national Master (civilingenjör) Program in Space Engineering kicked off space education at LTU in the fall of 1997. It has two areas of expertise: 1) Instrumentation and spacecraft, and 2) physics of space and the atmosphere. Spacecrafts and Instrumentation is a clear system perspective specialization. The design, operation, and communication of satellites are covered for the students. They practice planning and building instruments for sounding rockets, high-altitude balloons, and satellites. Space plasma physics and Earth's atmosphere are the primary areas of study in the specialization Space and Atmospheric Physics. Polar atmosphere phenomena, such as space weather and climate change, are of particular interest. The program has always been popular, and over the past five years, of all LTU's Masters Programs, it has received the most applications [3].

The Space Master is a 120 ECTS Master Program with four semesters. It has a first year that is the same for all students and takes place on the Kiruna Space Campus at LTU. The students are split up among the partner universities during the third semester, where they learn about various aspects of space science and technology. During the application process, which ends in the middle of January each year, students choose their specialization track. Almost every aspect of space education is covered by the various specializations. This makes it possible for academic staff at both universities to exchange professional research and teaching experience, which raises the standard of education offered [4].

Five strategic priorities for education and training were established in the new Strategic Framework for Education and Training 2030, which was approved by the Council of the European Union in February 2021.

- Enhancing education and training quality, equity, inclusion, and success for all.
- Making mobility and lifelong learning a reality for everyone.
- Boosting education professionals' motivation and skills.
- Bolstering higher education in Europe.
- Assisting with the digital and green transitions through education and training.

These priorities, in addition to recent trends in the global labor market, necessitate ongoing evaluation and rethinking of education, putting special demands on the educational sector. Students pursuing graduate and postgraduate degrees are expected to possess superior subject knowledge, a comprehensive comprehension of contemporary working practices, technical and higher-order thinking, engineering intuition, and problem-solving abilities. Modern space projects necessitate not only academic expertise but frequently also experience working with a wide range of international partners to solve difficult professional problems that call for a global perspective. This includes knowing about interactions between groups that shape and encourage positive attitudes in a social setting and, as a result, make people more effective. That necessitates well-honed skills in collaboration and communication. The Competence Ecosystem, which is made up of various actors with different roles who share a common vision and collaborate, is the only way to meet these multiple requirements. Five blocks make up the conceptual framework for a Competence Ecosystem at LTU for the efficient implementation of national and international master programs in space science and technology: academic partners, space agencies and organizations, educational programs and alliances, research at universities, and industrial and business partners [5].

Educational programs, particularly those at the Master's and PhD levels, must be founded on cutting-edge research that also anticipates active collaboration within various alliances if they are to be sustainable, competitive, and appealing. Examples of such extremely fruitful educational collaborations include the previously mentioned Space Master Program and Erasmus + Mobility. The newly formed UNIVERSEH Consortium, LTU's Graduate Schools in Space Technology, and Creaternity are additional examples. These alliances take a holistic approach and are based on a wide range of research topics, which not only provide a solid foundation for interdisciplinary collaboration but also make it easier to think in terms of systems. Diverse fields of engineering, the human and social sciences, the economy and business, cultural studies, innovation and entrepreneurship, and university research are all examples of multidisciplinary. The educators need to keep up with the most recent trends in the workplace, collaborate with academic institutions, regularly interact with space agencies, and establish a strategic partnership with business and industry entities in order to create this multidisciplinary environment and strengthen interdisciplinary interactions. It was recognized that a key success factor for engineering students' professional training is connections to the workplace through systematic active industry involvement in education [5].

Conclusion

Professional skills in the form of well-developed abilities for communication and teamwork, typically in an international setting, are also required of graduates. Project-based learning can fulfil these requirements as a complementary teaching method. Deep learning, the ability to apply previously learned knowledge to new problems and situations, and a variety of competencies related to human interaction and self-management are the goals of project-based learning. It has the potential to foster a positive learning environment and bolster productive relationships between teachers and students. According to Boyd and Hipkins, learning is meaningful when the topics covered are pertinent to students and the "real world." Project-based learning fosters a positive learning environment as well as relationships between students and teachers. This is in addition to the objective of increasing content knowledge and application. Modern space projects are very expensive, have a global perspective, and involve intricate professional issues. They require extensive international cooperation in addition to academic expertise. One of these projects' success factors is human interaction. Space students must therefore acquire the skills necessary to function in a global setting. This includes knowing about interactions between groups that influence and foster positive attitudes in a social setting. The framework for formal education should be used to train for these qualifications. However, the learning interactions should extend beyond the classroom, so this is a necessary but not sufficient condition. Therefore, it is necessary to combine formal and informal and non-formal learning. In recent years, there has been a lot of discussion about the significance of complementarity between formal, informal, and non-formal learning. The science and technology environment should be vibrant and completely open to student choice. When the issues discussed are relevant to students and the "real world," learning has meaning. In this regard, proximity geographically and strategic partnership with academic, business, and industry organizations become crucial. Students can take part in senior researchers' and engineers' research seminars, workshops, international student competitions, and national and international conferences and events. Schools and educational events in entrepreneurship and innovation are organized by university business entities like LTU Business AB. It has been determined that the presented Competence Ecosystem for space science and technology is an efficient and long-lasting tool for developing a new generation of competent space workers who are capable of addressing global challenges, advancing the New Space agenda, and achieving the strategic goals of the European Union's new space program.

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Conflict of Interest

None.

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