AI COMPETENCE FOR SWEDEN - A NATIONAL LIFE-LONG LEARNING INITIATIVE

F. Heintz[1], A. Loutfi[2], P.O. Larsson[3], J. Axelsson[2], S. Byttner[4], S. Eck[5], J. Gulliksen[6], N. Gustafsson[6], L. Kari[6], F. Lagergren Wahlin[7], H. Lindgren[8], M. Liwicki[9], A. Mannelqvist[8], S. Norrman[10], J. Smith[3], M. Staron[7], C. Ulvmyr[2], K. Åström[10]

[1]Linköping University (SWEDEN)
[2]Örebro University (SWEDEN)
[3]Chalmers University of Technology (SWEDEN)
[4]Halmstad University (SWEDEN)
[5]Mälardalen University (SWEDEN)
[6]KTH (SWEDEN)
[7]Gothenburg University (SWEDEN)
[8]Umeå University (SWEDEN)
[9]Luleå University of Technology (SWEDEN)
[10]Lund University (SWEDEN)

Abstract

AI Competence for Sweden, funded by the Swedish government, was launched in 2018 and engaged seven universities with established AI track-record to build a national platform for professional education in AI, both for the private and public sectors. The project has provided opportunities for the universities to work together on this important topic, which has resulted in both new education and many lessons learned. This paper outlines the major achievements, key lessons, and based on these proposes recommendations for the future. The intention is to share our collective insights to serve as an inspiration for future initiatives both within Sweden and internationally.

Keywords: AI, professional education, life-long learning, university collaboration, higher education.

1 INTRODUCTION

In 2018, two ministries of the government of Sweden worked together to launch a life-long learning initiative in Artificial Intelligence (AI) geared towards working professionals and engaging several Swedish universities. The intention of the initiative was both to meet a growing industrial need for working professionals to stay up to date with the developments in AI and to support Higher Education Institutions (HEIs) to offer life-long learning opportunities for working professionals. Given the work context of professionals, the most attractive format would be short, modular courses providing knowledge and skills that can be applied at work in both public and private sectors.

The initiative called AI Competence for Sweden engaged and supported seven universities, all with an established track-record in AI, to deliver courses for working professionals in AI. The initiative has been run as a project with a funding of EUR 4 million for 2018-2019 and some additional funding for 2020. Under the coordination of one of the universities, Chalmers University of Technology, the project supported the creation of new courses, workshops, events, a web portal, and perhaps most importantly, a joint platform allowing these universities to collaborate.

This paper gives an overview of the AI Competence initiative, the major achievements, the key lessons learned, and based on these proposes recommendations for the future. The intention is to share our collective insights to serve as an inspiration for future initiatives both within Sweden and internationally.

2 AI COMPETENCE FOR SWEDEN

The overall aim of AI Competence for Sweden was to improve the possibilities for working professionals to learn about AI, thus improving the competitiveness of Swedish companies and increasing the welfare provided by public organisations. Usually, funding of this kind comes with detailed regulations. In this project, the participating universities were given free hands to organise the initiative. This allowed the

universities to adapt to local contexts and design offerings to match the needs of local industry and public sector organisations. The autonomy of the universities turned out to be instrumental for the success of the initiative as each university could balance between the national and the regional contexts.

The two main tasks were:
a) Develop a knowledge platform. This included establishing a collaborative working model and the development of a web portal to present courses and activities.
b) Develop and deliver new AI courses for working professionals. Information about the courses were published on the web portal.

The initiative has engaged seven universities: Chalmers University of Technology, University of Gothenburg, Linköping University, Lund University, Örebro University, Royal Institute of Technology (KTH), and Umeå University.

Each member university appointed two members to a steering committee. The steering committee has convened once every three months. The universities have taken turns to host the steering committee meetings. During the meetings, each university has reported its work within this initiative and its other AI-related activities. The meetings have served as a platform for discussing common issues and the meetings have been a source for exploring possibilities of collaboration between the universities. In 2020, three additional universities (Halmstad University, Luleå University of Technology, Mälardalen University) joined the steering committee.

Chalmers, being the coordinator of the project, worked together with an external supplier to develop the web portal. Care was taken to design a web site whose contents could be edited by non-experts. This allowed each member university to have a login and editing rights to publish their own courses. The web portal has not had any functionality for registration to courses. Instead, visitors interested in a course on the portal would be redirected to a landing page on the website of the university in question.

Some of the courses on the portal were the result of course development sponsored by the project. In addition, the universities published their other existing AI courses for working professionals. Thus, this initiative gave the universities a marketplace to expose also other courses that they had in their portfolio.

Each course is tagged with its characteristics to allow for easy search. The following tags are used:
- Topic (could be more than one for a course, e.g., data science and machine learning)
- Location (venue or online)
- Start date (or self-paced)
- Duration (days)
- Level (basic / advanced)
- Language of delivery (English/Swedish)

Non-member universities have also been invited to publish their courses on the web portal and some universities have taken this opportunity. Today, 13 universities publish their courses on the portal (see Figure 1).

International Collaboration The AI4EU Platform is a large European initiative that aims to bring the AI Ecosystem stakeholders and AI resources one dedicated place, overcoming fragmentation, so that AI-based innovations (research, products, solutions) is accelerated. The AI4EU platform acts as a so-called one-stop-shop for AI-related technology, services, software, and experts. Part of the AI4EU platform consists of an education space, similar to the one by AI Competence for Sweden. The platform serves as a tool and catalogue to provide access to European educational efforts. Members of AI Competence for Sweden are involved in partnership with the AI4EU platform with particular engagement in ethics and leading the development of the education space on AI4EU.

Figure 1. Categories and classification of types of courses

Topic	Examples of Industrial Relevance	Examples of Courses
Machine Learning		
Machine learning (ML) is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) from data, without being explicitly programmed.	Predictive maintenance, document classification, customer behavior prediction, demand and supply estimation, automated testing	• Introduction to Machine Learning • Reinforcement Learning • Artificial Neural Networks & Deep Learning • Deep learning and Generative Adversarial Networks
Computer Vision		
Computer vision is an interdisciplinary field that deals with how computers can be made to gain high-level understanding from digital images or videos. From the perspective of engineering, it seeks to automate tasks that the human visual system can do.	Autonomous driving, automated image understanding, security and safety applications	• Digital Image Processing • Image Analysis and Computer Vision • Object recognition
Robotics		
Robotics deals with the design, operation, and use of robots, as well as computer systems for their control, sensory feedback and information processing.	Automated solutions in manufacturing, logistics, mining and inspection	• Autonomous Robots and ROS • Sensors and Perception • AI for robots
Humans and AI		•
From a system perspective, people and AI applications interact. AI will have a profound impact on how people organize their lives **and** society. Under this heading, we have collected courses dealing with the human aspects of AI.	Relevant for any application that requires non-experts to interact with an intelligent system	• Fundamentals of Human Machine Interaction • Virtual, Augmented and Mixed Reality • Human-Robot Collaboration • Human-Computer Interaction and AI
Planning and Scheduling		
Planning and scheduling concern the realization of strategies or action sequences, typically for execution by intelligent agents, autonomous robots and unmanned vehicles. Unlike classical control and classification problems, the solutions are complex and must be discovered and optimized in multidimensional space.	Multi-robot and vehicle coordination, autonomous vehicles and mining, multi-vehicle in defence, advanced production with autonomation	• Planning, Search and Optimization • Soft computing • Multi-robot coordination
Knowledge Representation and Reasoning		
Knowledge representation and reasoning are dedicated to representing information about the world in a form that a computer system can utilize to solve complex tasks such as having a dialog in a natural language. Knowledge representation incorporates findings about how humans solve problems and represent knowledge.	Decision support systems, semantic web, database design	• Automated Reasoning • Explainable AI • Expert Systems
Intelligent Agents and Multi-agent Systems		
An intelligent agent is an autonomous entity that observes through sensors and acts upon an environment using actuators and directs its activity towards achieving goals. Intelligent agents may also learn or use knowledge to achieve their goals. They may be simple or complex. Multi-agent systems include several interacting intelligent agents in the same environment.	Smart factories, digital twins, advanced production systems, smart cities, and monitoring.	• Artificial Intelligence and Multi-Agent Systems • Multi-agent Simulation
Natural Language Processing		
Natural Language Processing is concerned with the interactions between computers and human, natural languages, how to program computers to process and analyze large amounts of natural language data.	Human Computer Interaction, Customer Service, Automated Document Handling, Chatbots	• Natural Language Processing Principles • Interactive AI
AI and Machine Learning Applications		
Machine Learning is a field within AI where there are many applications that already have been deployed in engineering, business and society.	Relevant for specific sectors	• AI & ML in Medicine • AI & ML in Social Sciences • AI & ML in Economics
Prerequisites and implications of AI		
Many topics straddle several disciplines. We have collected such courses under this heading.	Relevant for all applications of AI methods	• Ethical, philosophical and legal aspects in AI and robotics • Preliminaries in AI and autonomous systems • Business implications of AI • AI for decision makers

3   MAJOR ACHIEVEMENTS

Established a Platform for Cooperation Between People with Key Roles at Seven Universities
The regular steering committee meetings have created a platform for mutual exchange of ideas and best practices. The initiative has become a catalyst for creating working relationships between people

at the involved universities. At some instances, universities have jointly delivered events. Besides the steering committee there has been a working group for communication with representatives from each university. The working group has focused on the establishment and improvement of the web portal.

Developed and Delivered Short Courses for Working Professionals The project has provided funds for developing courses tailored to working professionals. During the period 2018-2020, there have been 106 courses on the portal, some of them delivered several times. The lengths of the courses have varied from less than a day to several weeks. More than 30 percent have been online courses. Education initiatives among the universities varied and took different forms, from workshops and events to formal courses.

Established a Web Portal and Catalogue of Courses Based on input from the member universities, a web portal (https://ai-competence.se) was launched in 2018. The purpose of the web portal is to expose available AI courses offered by the universities.

The portal has collected and presented courses from many universities in one place, thus facilitating for working professionals to get an overview of offerings from Swedish universities. Apart from presenting the courses, the web portal has inspired visitors to learn more about what the universities are doing in the area of AI.

Offered the Possibility to Promote Existing Courses on the Web Portal The web portal has been a platform to promote all life-long learning AI courses that a university offers. In fact, most of the courses on the portal have been developed by other initiatives than AI Competence for Sweden.

Provided Economic Support and Funding to Facilitate the Universities Interaction with Industry he project has given the universities resources to spend time with industry and public sector organisations to understand their needs of continuing education for their employees.

Demonstrated to the Business Community a Collective Effort by Universities to Offer Life-long Learning There has been a signal value to show that universities in Sweden can join forces to help society with competence development in this important area.

4   LESSONS LEARNED

Through the AI Competence initiative, we have learned a lot about life-long learning in practice in the university environment. For example: how to work with admissions, how to certify that students/participants actually took part of the course, and how to engage teachers. Below we describe some of these in some detail.

The Need to Clarify the Role of Higher Education Institutions (HEIs) in Professional Education and Life-long Learning. In Sweden, as well as elsewhere, universities are undergoing a profound change. This change, pushed forward in part by an increasing digitalisation, is highlighting the role of Higher Education Institutions in life-long learning (LLL). There is a plethora of continuing education offerings by private providers on the market. Yet, HEIs may provide a clear added value thanks to their academic rigour and their vast experience of teaching AI to regular students. In the current landscape of needs among private and public-sector organizations, there is a place for universities to provide continuing-education courses.

AI Competence for Sweden has made clear that there is a need to clarify the role of HEIs with respect other educational providers in terms of LLL initiatives. This is essential to avoid inundate the current private providers and ensure an effective use of resources.

The Challenge of Coordination with Other Publicly Funded Initiatives There have been other publicly funded projects going on in parallel with AI Competence for Sweden. Some of these projects have also aimed at developing and delivering courses in the AI area. At first, there were some challenges regarding how to relate to these initiatives in the best possible way. Thanks to the web portal developed by AI Competence for Sweden, we had a platform to promote those courses. As an example, Vinnova funded the translation and introduction of the Finnish course Elements of AI to Swedish, a course now available on the web portal.

The Importance of Adapted Learning Formats Regular university courses are structured with weekly lectures and courses span several weeks. This is a format adapted to full-time, regular students. The context is different for working professionals, such as managers, decision-makers, civil servants, and

developers. Working professionals rather look for short, intensive courses that can speed up their learning curve and build actionable competencies. Since these people are in the position to promote and drive change in their organisations, they are important to reach.

General managers and leaders in large organizations seldom have any training in AI and for them the concept itself is sometimes hard to grasp. They do not have time to spend several weeks at a course learning about a subject they may not see the direct use of in the short term. Therefore, some universities have decided to provide adapted formats for their AI learning initiatives. These formats range from one-hour breakfast/lunch seminars and half-day workshops, to introductory courses lasting a few days. In general, no academic credits are granted. Such learning opportunities have been appreciated among participants.

Other learning formats have included platforms for dialogue and exchange of thoughts, strategies, knowledge and experience among participants and organisations. The platforms also served as a means for the university to learn and adapt to the participants' organizational realities in industrial settings. One insight from these encounters is that the challenge to deploy AI solutions is not only of technical nature. The real problem resides in the organizational structures, routines and procedures in the home organization. Applying AI most often also implies changing the being and doing of the organization itself.

Matching Course Contents with Participants' Needs AI is an evolving field, which means that many organizations lack a clear picture of what they need. Thus, the requirement specification may be fuzzy, making it hard to design courses that meet needs, as these are unclear and may change. After completion of a course development, it may turn out that the customer would have needed something different. A lesson is that course designers from the university must gain more insight about the work of potential participants to design courses that match actual needs. Many organisations do not know, or in the best case, have a very unclear idea, of what they need in terms of AI education.

Quality Assurance and Agile Course Development There is a difference between academic courses and the more flexible continuing-education activities. For the latter, there is usually neither formal admission nor examination. This simplifies course development, thus offering the option of a more agile approach with a short lead-time to deliver a course that the customer wants. At the same time, care must be taken to ensure the quality to meet the standards of an academic institution.

Therefore, there is a need to develop a different quality assurance system and that the courses are at the university quality level.

Challenges for Adult Learning in Artificial Intelligence The challenges of adult and professional education have been extensively studied [1,3,6,7,8]. The main challenges are that participants have varied backgrounds, that the content is quite far away from what the participants normally work with and that it has been a long time-lapse since they last studied.

To be able to learn to do AI, rather than only learn about AI, you need to be able to do simple programming. Often some mathematical understanding is also required. Many people have sufficient mathematical background, even though it can be quite far back. However, most lack sufficient programming skills. They might have basic knowledge of programming, but have not used it, which means that programming tasks take a lot of time and can be frustrating. A significantly higher level of digital competence, including being able to use programming as an active tool would make a huge difference.

We found that many of the students said "we have been away from studies very long, and have lost the ability to study". Indeed, when teaching for adult professional learners there is a risk that students have simply forgotten the background knowledge or forgotten study technique. We addressed this by allowing the courses to span over a longer time to allow students to familiarize themselves with being in a study environment. In some courses, we have added refresher content, e.g., in mathematics.

A related challenge is that it is often hard to define the prerequisites and to validate that the participants satisfy them.

Deployment and integration of New AI Competencies in the Home Organization One reflection is that companies need assistance on how to take advantage of the new competencies that their staff have after completing professional education, especially since many companies are not AI ready yet [4]. Universities can play a role to assist the companies with how to further integrate new competencies in their organisations and ensure that the learner's new competence is transferred to the workplace.

Lack of Long-term Funding has Prevented Resource Allocation and Promotion of the Initiative Universities operate with multi-year planning of resource allocation. To build a sustainable organisation to maximize the effect of initiatives, the universities require long-term funding.

This initiative has received funding one year at a time without any guarantees of long-term funding. This has limited the possibilities for the universities to plan ahead and build a stable organisation for the project. It has been a challenge for the universities to establish resources and engage in course development that spans over more than one year. An additional challenge is that we started from nothing in terms of common infrastructure, which meant that we needed to invest some resources on top of the funding received.

If we had known from the beginning that this would be a longer, multi-year initiative (3-5 years), many things would have been simpler and we could have been better in planning, coordinating and deploying the courses; we could have planned for the integration with the existing infrastructure beyond the end of the initiative. The lack of long-term funding has made it difficult to employ additional academic teachers, something that is needed at several universities to be able to deliver more courses.

Training as a Professional Service or a Free Utility Provided by the State One difficulty has to do with the willingness to pay for the delivery of courses. In the Swedish context, companies are used to pay for continuing education of their employees. Professional education courses provided by universities, whether they are programmes, e.g., MBAs or short professional courses lasting a few days, normally have a price tag attached.

The courses sponsored by this initiative are offered on the market, most of them free of charge. Experience has shown that companies are eager to take advantage of free courses instead of paying for the same services. The web portal presents courses both with and without tuition. Those courses without tuition are those that have been sponsored by public funding, AI Competence for Sweden or other projects. Big differences in pricing can lead to unfair competition both between universities and with other commercial providers.

During recent years, there has been a mix of offerings of "free" AI-related courses. Thus, it has been hard for the continuing-education units at the universities to get paying customers for their courses. Competition exists in the form of free seminars, online platforms like Coursera, EdX etc., and some Swedish universities starting to provide continuing education for free or below a market price. This development has disrupted the market. On the one hand, it is positive that AI knowledge is spreading, and that continuing education is available for free. On the other hand, this development creates problems for some universities arranging continuing education as a business and forces them to rethink their business models. Explicit rules about pricing would help universities develop their full potential in life-long learning.

5   RECOMMENDATIONS

Integrate Life-long Learning in the Everyday Activities of Universities through Explicit Mission and Funding A current problem is the lack of teaching personnel who can engage in continuing education. Long-term funding for AI Competence for Sweden would create stability and encourage the universities to allocate permanent resources. Such funding would give the momentum to deepened collaboration between universities.

Extend the Initiative to Cover All Universities Today, there are seven universities in the project. There are other universities that have continuing education courses and that are interested in collaboration. Three additional universities have attended the steering-committee meetings and even more universities list their courses on the portal. This project would benefit if additional universities could join the project and it would require wider funding. A complete participation among Swedish universities would show society that all HEIs with AI courses had joined forces to offer courses.

Systematic Promotion and Increase Visibility of Web Portal With long-term funding, it will be possible to improve the visibility. AI Competence for Sweden would be the natural touchpoint to which people and organizations turn when it concerns university-based life-long learning in AI. We should also open the portal for other actors and develop quality assurance methods so that the courses in the portal are guaranteed a specific quality level.

Establish a Reference Group with Representatives from Private and Public Sectors to Better Capture their Situation and Needs Universities have the experience of teaching AI to regular students. Working professionals operate in the context of their organisations. The organisations can help understand what topics should be taught and how courses should be delivered to meet the needs of the organisation. A reference group consisting of HR people and line managers from private-sector, public-sector and non-governmental organisations could help guiding the universities to develop courses that meet actual needs. This could for example be done in collaboration with other initiatives such as AI Sweden.

Better Coordination of Different Initiatives and Pooling of Resources to Achieve Economies of Scale The current three years of experience of the project have shown that it is possible to create a working relationship between universities regarding the supply of AI courses. This far in the project, the universities have developed their own courses. Sometimes these courses have had contents overlapping the contents of courses from some other university. With a deeper collaboration, it would be possible to share designs and pool resources to save money and boost the output.

Continuous Evaluation and Quality Assurance of Courses and Activities to Improve Educational Offerings Each university has been responsible for the evaluation of its delivered courses but there has not been any coordinated evaluation across the universities. By compiling all evaluations, it would be possible to find patterns that could guide how to design future courses. A further step would be to design a common evaluation method. Such a method could include both questionnaires and post-course interviews with participants.

By combining evaluation results with what we know about organisations and their needs, we could design a maturity model for data science and AI. Then we could design a structured set of courses for organisations that want to improve their maturity.

Collaborate with International Initiatives, especially on the EU Level AI is a hot topic not only in Sweden but also in most other countries [2,5,9]. There are similar initiatives outside Sweden, e.g. [10]. A way to learn from these would be to first study the anatomy of such initiatives and then establish direct contact with key people for mutual learning. Likewise, international initiatives have shown interest to learn more about AI Competence for Sweden. Thus, there is fertile ground for creating working relationships between our initiatives for mutual benefit.

6   CONCLUSIONS

AI Competence for Sweden, funded by the Swedish government, has been a successful initiative that has established the basis for long-term collaboration between many Swedish universities in life-long learning. The 4 million EUR investment from the government was instrumental in kick-starting this collaboration. The next major step is to integrate the lifelong-learning activities in the normal everyday work of the universities. It is paramount that we expand and sustain the life-long learning activities within the universities, rather than building new parallel systems. This is best done by significantly increasing the general funding for education and broadening the assignment to the universities to explicitly include life-long learning.

The success of our society depends to a large degree on how well we manage to upgrade our citizens to keep up with the technological developments. AI Competence of Sweden is a good example of how a country can ramp up its efforts and establish national collaboration and an effective organization for large-scale continuing education.

REFERENCES

[1]   S. Cornelius, C. Gordon, & A. Ackland. "Towards Flexible Learning for Adult Learners in Professional Contexts: An Activity-Focused Course Design". *Interactive Learning Environments*, 19(4), 381-393, 2011.

[2]   M. Craglia (Ed.), "AI – A European Perspective", EUR 29425 EN, Publications Office, Luxembourg, 2018.

[3]   H. Davis. "Discussion as a Bridge: Strategies that Engage Adolescent and Adult Learning Styles in the Postsecondary Classroom". Journal of the Scholarship of Teaching and Learning, 13(1), 68-76, 2013.

[4]   J. Holmström, "From AI to digital transformation: The AI readiness framework". *Business Horizons*, 2021.

[5]   A. Jaiswal, J. Arun, and A. Varma, "Rebooting employees: upskilling for artificial intelligence in multinational corporations". *The International Journal of Human Resource Management*, 2021.

[6]   P. Jarvis. Adult Education and Lifelong Learning: Theory and Practice, 3rd ed. London: Falmer Press, 2004.

[7]   K. Milheim. "The Role of Adult Education Philosophy in Facilitating the Online Classroom". Adult Learning, 22(2), 24-31, 2011.

[8]   K. Rubenson, K. Adult Learning and Education. Saint Louis, Mo.: Academic Press, 2011.

[9]   D. Spencer, M. Cole, S. Joyce, X. Whittaker, and M. Stuart. "Digital automation and the future of work", European Parliamentary Research Service, 2021.

[10]   A. Taylor, A. Green and S. Hassan. "Priorities for up-skilling and re-skilling: what role can and should universities play?" Technical Report Birmingham University, 2021.