Experience in implementation of «Nuclear Knowledge Management» course at the National Research Nuclear University MEPhI

N I Geraskin and A N Kosilov

Department of theoretical and experimental physics of nuclear reactors, National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Kashirskoe highway, 31, Moscow, Russia

E-mail: NIGeraskin@mephi.ru

Abstract. This paper describes the experience of teaching «Nuclear Knowledge Management» course at the National Research Nuclear University MEPhI (NRNU MEPhI). Currently, the course is implemented both in engineer and master degree programs and is attended by over 50 students. Goal, objectives and syllabus of the course are discussed in detail. A special attention is paid to practical exercises and final examination options in the case of small and large student groups. The course is supported by the Cyber Learning Platform for Nuclear Education and Training (CLP4NET), developed by the IAEA. The experience of NRNU MEPhI lecturers assisting in conducting the International School of Nuclear Knowledge Management, held annually in Trieste (Italy), is described with a special attention to the fact, that the course has passed the certification process at Academic Council of NRNU MEPhI. In 2014 and 2015 the course has been recognized as one of the best ones in NRNU MEPhI. Finally, perspectives of «Nuclear Knowledge Management» course are considered. They include increase of the course duration, introduction of the course into the learning process of other departments and institutions of the university, and transferring the course to other members of the Association «Consortium of ROSATOM supporting universities».

1. Introduction

International Atomic Energy Agency (IAEA) in collaboration with leading nuclear universities aims at establishing International Nuclear Management Academy (INMA). The purpose of INMA is to create and implement, in collaboration with the members of the academy, the master degree program in the field of nuclear technology management in compliance with IAEA standards, as well as to develop uniform requirements for master degree programs with an emphasis on modern aspects of management in the field of nuclear science and technology.

At IAEA General Conference held in September 2015 an agreement has been signed, under which National Research Nuclear University MEPhI (NRNU MEPhI) becomes an official member of INMA. It is assumed that a new master degree program on nuclear technology management will be implemented in NRNU MEPhI in September 2016. This new program is highly anticipated as currently there is no uniform international program that takes into account the peculiarities of highly qualified managers training in technical universities, and such professionals are required for the successful development of nuclear energy.

An important part of the new master degree program on nuclear technology management is the course «Nuclear Knowledge Management» (NKM), which is already being implemented at the
department of theoretical and experimental physics of nuclear reactors since 2012. The experience of teaching this course should be used in the development of a new master degree program in NRNU MEPhI. The present paper summarizes this experience.

2. **General information about the course «Nuclear Knowledge Management», implemented in NRNU MEPhI**

The goal of the course «Nuclear Knowledge Management» is studying main approaches, methods and tools of knowledge management (KM) as a key resource in the enterprises of the nuclear industry.

Currently, the course is implemented both in engineer and master degree programs: ninth semester of engineer degree program (educational direction 14.05.01 «Nuclear reactors and materials»); first semester of master degree program (educational direction 14.04.01 «Nuclear power and thermal physics» and 14.04.02 «Nuclear physics and technology»).

In 2015 the course was attended by 58 students. The geographical scope is wide enough: there were students not only from Russia, but also from other CIS countries and far abroad.

Objectives of the course include studying issues of effective KM, aimed at ensuring and improving safety, reliability and efficiency of nuclear facilities operation with a view of their long-term competitiveness and sustainability by means of using knowledge resource.

According to IAEA recommendations the course consists of eight lectures and practical exercises [1]. The course plan is presented in table 1.

**Table 1.** «Nuclear Knowledge Management» course plan, implemented at the NRNU MEPhI.

| Title                                      | Main topics                                                                 |
|--------------------------------------------|-----------------------------------------------------------------------------|
| Knowledge Concepts and Definitions          | What is Knowledge?                                                          |
|                                            | Knowledge as a Resource                                                     |
|                                            | Nuclear Organization and Nuclear Knowledge                                  |
| KM History and Development                  | KM History, Definition and Models                                           |
|                                            | KM Elements, Importance, Benefits, Tools and Techniques                    |
| KM in Nuclear Science & Technology          | KM Approaches                                                               |
|                                            | Nuclear Knowledge & Stakeholders                                            |
|                                            | Nuclear Knowledge Management                                                |
|                                            | Knowledge Loss Risk Assessment                                              |
| Managing Tacit Knowledge                    | Tacit Knowledge                                                             |
|                                            | Techniques to identify, capture and transfer tacit knowledge                |
|                                            | History of Nuclear Information                                              |
| Managing Nuclear Information               | Methods and Tools for Information Management                                |
|                                            | Knowledge Organization Systems                                              |
| NKM Organizational Challenges              | Integration of NKM in Organizational Management System                      |
|                                            | Knowledge-sharing Culture                                                   |
|                                            | Set Up, Implementation and Assessment of NKM Projects                       |
| Implementing KM in Nuclear Organizations    | KM in Nuclear Power Plant                                                   |
|                                            | KM in R&D Organization                                                      |
|                                            | KM in University                                                            |
| NKM Maturity Assessment                     | KM Assessment: Elements and Steps                                           |
|                                            | IAEA Self-Assessment Model                                                  |

During practical exercises the students acquire skills how to preserve critical knowledge and build concept knowledge maps.
The goal of the first practical exercise is to assess risk of knowledge loss on the basis of interview data and to propose measures for critical knowledge preservation [2, 3]. Students work in small groups of 3-5 people and answer the following questions using interview data: what knowledge is critical, what are the consequences of losing this knowledge, and how to mitigate the negative effects of losing this knowledge. After completing the task one of the groups presents their results, while other groups may discuss the presentation.

The goal of the second practical exercise is to build a concept map for some area of knowledge, for example, nuclear reactors designing. For this exercise students use free specialized program CmapTools (available at http://cmap.ihmc.us).

The final examination is an essay. The following topics are possible:

- Methods of explicit and tacit knowledge management.
- Tacit knowledge preservation using concept map technique.
- NKM in research institutes / NPP.

Authors of the best essays present their work as an oral report at the International School-seminar «Nuclear Energy and Non-proliferation: answer for today challenges», traditionally held by the department «Theoretical and Experimental Physics of Nuclear Reactors» in January-February.

However, essay is not an appropriate solution for large student groups. That’s why we proposed to use projects in autumn 2015. Each group of 4-6 students has developed their own project. Project’s topics are as follows:

- Implementation of knowledge management program in NPP / nuclear regulatory body / nuclear research and development organization.
- Knowledge map development for the leading staff of department of theoretical and experimental physics of nuclear reactors (NRNU MEPhI).
- Knowledge portal implementation for department of theoretical and experimental physics of nuclear reactors (NRNU MEPhI).
- Taxonomy development for course project on nuclear reactors designing at department of theoretical and experimental physics of nuclear reactors (NRNU MEPhI).

Practical significance and good understanding of the projects (many students had course project on nuclear reactors designing in one of the previous semesters) ensured high interest of students and great quality of presentations.

On the basis of experience of using e-learning/distance training systems the course «Nuclear Knowledge Management» is realized on Cyber Learning Platform for Nuclear Education and Training (CLP4NET), developed by IAEA [4]. Advantages of the CLP4NET platform are support by IAEA, no fee for IAEA members, as well as multi-language interface. NRNU MEPhI is the point of Russian localization of the platform supporting national and international educational activities and trainings.

The CLP4NET platform can be used for development, management and dissemination of the educational on-line materials in the operation mode of joint access. The educational materials may be created in visual environment with definition of the learning sequence. Various forms of individual tasks, projects for small teams, any educational elements (including both cognitive and communicative components) can be placed on the CLP4NET platform for all trainees. The CLP4NET platform is characterized by high level of interactivity and, thus, the CLP4NET platform allows the trainees from other countries to participate in the educational process through the Internet system.

It should be noted that some lectures of the course are conducted through Internet by means of video conference technology. For the convenience of students user manual to CLP4NET platform has been developed. User manual explains the main issues (access to the platform, access to the courses, passing tests), is detailed (74 pages) and contains many illustrations.

On the basis of many years of experience in nuclear knowledge management issues in year of 2015 the first-ever in Russia textbook «Knowledge Management in Nuclear Organizations» has been published [5]. The textbook is intended for students and PhD students specializing in the field of nuclear technology, as well as for employees of nuclear industry enterprises. It is expected that the textbook will be published also in English.
3. International School of Nuclear Knowledge Management

Teachers of the course «Nuclear Knowledge Management» serve as lecturers and consultants at the International School of Nuclear Knowledge Management, held annually in Trieste (Italy). The School is organized jointly by The Abdus Salam International Centre for Theoretical Physics and IAEA. The School is very popular: in 2015 only one fifth from more than 200 submitted applications was accepted. The participants represented 28 countries.

The School consists of distance training using CLP4NET platform (during which students learn the basics of knowledge management), as well as full-time tuition in Trieste. The School program, covering 12 modules including implementation and defence of projects, has passed the certification process as an advanced training course for nuclear industry specialists at the Academic Council of the NRNU MEPhI. In this regard, the participants of the International School are awarded official advanced training certificates of the NRNU MEPhI.

The IAEA Director General Yukiya Amano, in his address to the participants of the School, noted the importance of effective knowledge management, aimed at increasing long-term competitiveness and sustainability by means of using a knowledge resource for high performance and safe operation of nuclear facilities, and praised the initiative of NRNU MEPhI on certification of the course «Nuclear Knowledge Management» as an advanced training course for nuclear industry specialists.

4. Perspectives and recognition of «Nuclear Knowledge Management» course

Experience of teaching the course «Nuclear Knowledge Management» at the department of theoretical and experimental physics of nuclear reactors allowed us to organize International Workshop on nuclear knowledge management «Formation of competences in the field of nuclear knowledge management within the frames of university educational programs» in NRNU MEPhI. The aim of the workshop was acquaintance of the experts of ROSATOM supporting universities with the modern techniques of intellectual capital management, possibilities of using various information resources in the process of nuclear specialists training, as well as participation in practical exercises on nuclear knowledge management.

Based on the experience of teaching the course «Nuclear Knowledge Management» in 2012-2015 one can identify the main directions of its development, partially already implemented:

- Increase in course duration from the initial 16 classroom hours to 20 classroom hours at present.
- Introduction of the course into the curricula of engineer degree programs in the autumn of 2015 that allows us to cover a wide audience.
- Possible introduction of the course into the learning process of other departments and institutions of NRNU MEPhI (department of automation and Obninsk Institute for Nuclear Power Engineering are considered foremost).
- Experience transfer to other members of the Association «Consortium of ROSATOM supporting universities».

As recognition, it should be noted that the course «Nuclear Knowledge Management» was a winner of the contest «Young Lecturer of NRNU MEPhI 2014». The course was one of 78 best courses submitted to the contest by young lecturers (under 35 years of age) from all NRNU MEPhI branches. As a result the course materials should be available on NRNU MEPhI educational portal http://online.mephi.ru/.

The course «Nuclear Knowledge Management» was also a winner of the contest «Young Lecturer of NRNU MEPhI 2015». This time the selection process was more rigorous (only 57 best courses were selected). The aim of this contest is to create video-lectures in English, which will be available as a massive open online course on leading world educational and training platforms such as EdX and Coursera.

References

[1] International Atomic Energy Agency 2016 Knowledge Management and Its Implementation in
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[3] International Atomic Energy Agency 2011 Comparative Analysis of Methods and Tools for Nuclear Knowledge Preservation (IAEA Publications STI/PUB/1494) p 102

[4] NKM e-Bulletin September 2014. URL: http://www.iaea.org/nuclearenergy/nuclearknowledge/NKM_NEWS/e-bulletin/2014-03-e-Bulletin-Septl.pdf

[5] Geraskin N I, Kosilov A N, Kulikov E G and Tolstenkov A N 2015 Knowledge Management in Nuclear Organizations: Textbook (Moscow: NRNU MEPhI) p 408