

KNOWLEDGE BASED METHOD OF ENHANCING PROFESSIONAL SKILLS OF SCRUB NURSES

Joanna BARTNICKA, Katarzyna MLECZKO, Teodor WINKLER, Daniel
DĄBROWSKI

Summary: This article aims to demonstrate the way of development of vocational trainings based on the knowledge management mechanisms. The method implemented during the work was verified on the example of a professional group of scrub nurses working in an orthopedic and trauma surgery operating suite. The article contains guidelines for the training needs identification and method to satisfy them. In particular the importance of diversification of the training content and forms of its communication using the modern ICT technologies was pointed out.

Keywords: knowledge-based training, knowledge management, *Ad hoc* training, teaching training, context training.

1. Introduction

The aim of this article is to describe the method including the knowledge management mechanisms, which helps to create modern trainings that teach and improve the professional skills.

The method was developed and verified on the example of a professional group of scrub nurses working in an orthopedic and trauma surgery operating suite. The need for the researches on how to support the operating suite activities, including the work of scrub nurses was revealed during implementation of the development and research project entitled:

Knowledge based method of improvement of the working conditions in the health care organizations, which ended in 2011 and was funded by the National Centre for Research and Development. The surveys carried out under the above mentioned project showed that the medical staff (nurses and physicians) [1] employed in the orthopedic and trauma surgery wards enhances its skills and knowledge gained through the exchange of experiences with colleagues, using the hospital's internal documentation or professional literature, training courses organized in and out of the place of work, participation in scientific conferences, to a lesser extent, the respondents draw information from the existing formal and legal acts (laws and regulations), the mass media and e-learning (via the Internet). However, it appears that almost half of the respondents believes that above mentioned methods of gaining information are insufficient. In turn, the vast majority of the surveyed employees from orthopedic and trauma surgery wards found it useful a direct access from their place of work to the information required to perform duties, including information about any changes and news. Most of them also consider that use of the modern ICT information and communication means might be useful to make available the resources of knowledge.

The surveys confirmed by interviews and the result of direct observation of the processes implemented in the health care units' orthopedic and trauma surgery wards

helped to identify the problem of lack of the trainings supporting the hospital's workflows and tailored to the user's needs (user friendly).

This problem manifests itself in the following areas:

- forms of the training content's presentation - usually limited to the information provided in the form of text, supplemented with pictures; currently being developed with audio-visual materials, animations, computer programs increasingly forcing to their active viewing,
- forms of providing the training content - books, catalogs and brochures; information of a static nature, often insufficient; extended by the ICT technologies, providing an access via the Internet, via mobile devices or PCs,
- place of the training - the place of work - at a designated room or in the workstation, training centers or conference centers; the specific nature of the training and of the provided knowledge determines choice of the place.

The commonly used forms of presentation of the training content are limited to a verbal communication in the form of text that can be supported by drawings showing the corresponding schemes or activities. Given the static nature of the content the presented information may be ambiguous or incomplete. The modern forms of training materials contain the content supporting the perception forms such as video and sound. The content represented with video materials, accompanied by appropriate voice guidelines helps the learning process by eliminating ambiguities and providing issues connected with the problem more fully and more easily absorbed. Sharing knowledge through the audio-visual techniques presenting in full the selected issue, in conjunction with the traditional text, gives the possibility to use additional senses, which contributes to increased efficiency of time spent on learning. The researches have shown that the traditional form of training of the scrub nurses includes only the materials developed in the form of a catalog and/or a book. Developing these forms of the ICT technologies allows an access to knowledge via the Internet and mobile devices. The use of mobile phones or PDA class devices allows providing an access to the educational materials in any place. The training can be conducted in the place of work - in the lecture hall or in the workstation. In the case of long-term trainings, aiming to provide or enhance the professional skills, they will be conducted in the place of work or at the training center. While for the enlargement of theoretical knowledge an outdoor trainings is usually chosen.

2. Knowledge management in the context of vocational trainings

The need for knowledge management has grown rapidly on basis of the civilization development, carrying a huge amount of unstructured and scattered information. The multitude and variety of the information resources made the finding, and then applying of the relevant information become time consuming and often complicated. Therefore the problem translates to effectiveness and efficiency of the employees.

Attention is drawn to the trend of specialization of the employees who are able to master the knowledge of only one field, and often only within its certain specialized segments [2].

The possibility of access to the relevant knowledge during a relevant time underlines the knowledge management issues in the context of the organization activity. In this article, the knowledge is therefore considered as a mean that is supporting and streamlining course and effectiveness of the activities in the work processes.

This approach to the knowledge is described in [3]. Here, understanding of the

knowledge is focused on the knowledge application process, or in other words, the awareness that the knowledge allows people to possess the qualifications and skills required to carry out specific tasks.

The advanced learning technologies are rarely integrated into the knowledge management systems. While the existing and readily available knowledge is defined, distributed and used by the users, the lack of such practices and teaching methods that would support the process of effective communication and learning, is suggested [4].

Undoubtedly, the effectiveness of trainings depends on the quality of the provided information. That quality is created by such factors as: accuracy, timeliness, completeness, relevance and coherence [5]. The provided information must also be readable and understandable to the user. The activity influencing the quality of information, and then the knowledge management is the resources to be the subject of trainings organizing.

Here, the criteria suggested for arranging the knowledge are the following:

- criterion of the knowledge codificativity,
- criterion of the knowledge content,
- criterion of the knowledge representation.

And so, having regard to the criterion of the knowledge codificativity, this can be divided into main three categories [6]:

- quiet (tacit) knowledge resources – the access to which is not direct, but through observation of behavior of the person who possess such the resources. It is an uncodified knowledge.
- implicit knowledge resources – the access to which is not direct, but occurs by asking questions or discussion. It is therefore also an uncodified knowledge.
- explicit knowledge resources: readily available, documented in form of the formal knowledge media. This kind of resources can be well organized with the help of the IT tools. They can also take the form of a paper documentation.

The criterion of content organizes the knowledge resources by grouping them into the procedural and declarative knowledge category [7]. Whereas, the procedural knowledge is a knowledge answering to the question “how” while, the declarative knowledge means its possession in the specific area, the so-called knowledge “that”. The procedural knowledge is largely an implicit knowledge relating to individual employees' skills, such as the knowledge needed to perform a complicated surgery. In turn, the declarative knowledge is largely an explicit knowledge, widely available and easy to be recorded and codified.

Taking into account criterion of the knowledge representation, the attention was drew to the size of the individual elements making up the knowledge that can be reused and combined according to the contextual situation and the type and content of the training. In the literature, such elements are referred to as the Reusable Learning Objects (RLO), E-learning Objects (ELO) or Shared Content Objects (SCO). The examples of RLOs can be video or audio, course modules, animations, graphics, websites, PDF files, documentation, and other elements that are designed to spread certain resources, e.g., in the form of a lesson based on the Internet [8, 9]. Special attention is paid to use of the RLOs in the contextual knowledge network made available to the employees through the modern communication technologies during the on-line types of training [10].

In the context of building of the knowledge management systems used for the professional skills improvement along with RLO, ELO, SCO the so-called Boundary objects are listed [11, 12]. The boundary objects are perceived as elements capable of

multiple sharing in different contextual problematic situations. These elements can be processes, artifacts, documents, or technical language or the language that is in common use.

3. Description of methods of the knowledge-based training creating

Taking into account the above-described problem area, during the development of the method the following assumptions were distinguished:

- the needs within the training content are identifiable, based on the organization processes research,
- the method includes a mechanism for the knowledge organizing, taking into account the criteria of codificativity, content and knowledge representation specified in Section 2,
- the method is based on the knowledge decomposition mechanism (in particular, inherent in the processes ongoing in an organization),
- within the same subject of the training the diversity of the content, length of the training and form of the communication based on the readability criterion occurs,
- the training may be either stationary or mobile.

For such the methods assumptions the vocational training preparation diagram was developed, fig. 1.

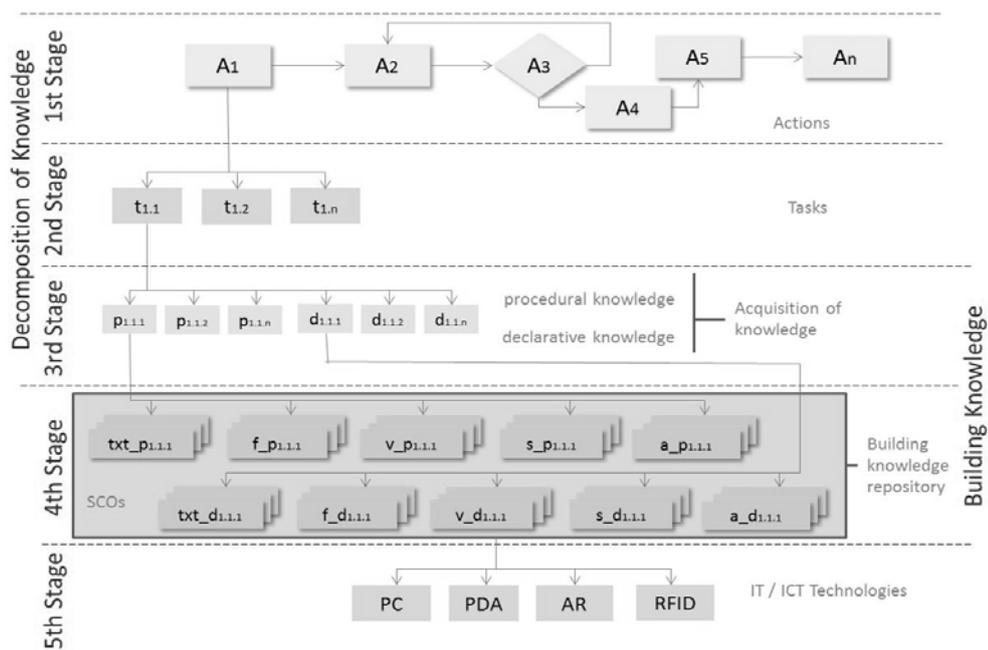


Fig. 1. Simplified scheme of preparation of the vocational knowledge-based trainings

The presented scheme of conduct includes the following steps:

1. Step one – is an analysis of the work processes, where the individual operations (Actions) were marked with symbol *A*. The purpose of this analysis is to initially establish the training needs.
2. Step two - indicates the need to clarify the process of analysis while directing the research to the level of tasks *t* implemented within the operation. The result of the second step are the clearly defined training needs, which form the basis for training content acquiring and organizing.
3. Step three - notes the outcome of organizing the knowledge, which is based on the knowledge division into the declarative *d* and procedural *p* knowledge. Such organizing of the training content allows searching for the sources of information being subject of the training, as well as the construction of models of the variant forms of training.
4. Step four - is responsible for building the repository of knowledge together with the accumulated SCOs. These objects may take the following forms: text *t*, figure *f*, video *v*, simulation *s*, audio *a*.
5. Step five: the resources collected in the repository will be accessible in different ways, depending on the context and the training's variant. The technologies involved in the discussed step are, in particular, the ICT technologies, such as Radio Frequency Identification FRIDA and Augmented Reality AR.

Attention was drawn to the process of decomposition of the knowledge derived from practice, which resulted in the separate elements of the declarative and procedural knowledge. Only such elements are the basis for the identification and creation of the reusable knowledge objects SCOs, and these form the basis for building knowledge-based training.

The subsequent sections of this article describe the selected aspects of building the training taking into account the processes of: training needs identifying, training variantivity modeling, training knowledge resources in the repository organizing and trainings sharing.

3.1. Identification of the training needs

The identification of the training needs is the first step in the professional skills improving. Its purpose is to define tasks and process elements that constitute bottlenecks. In particular, these bottlenecks may be the information gaps which extend the work processes or contribute to the error occurring.

A multi-step process of acquiring information and verification of the findings allows for an unambiguous determination of the training objectives. The diagram of such a process is illustrated in fig. 2.

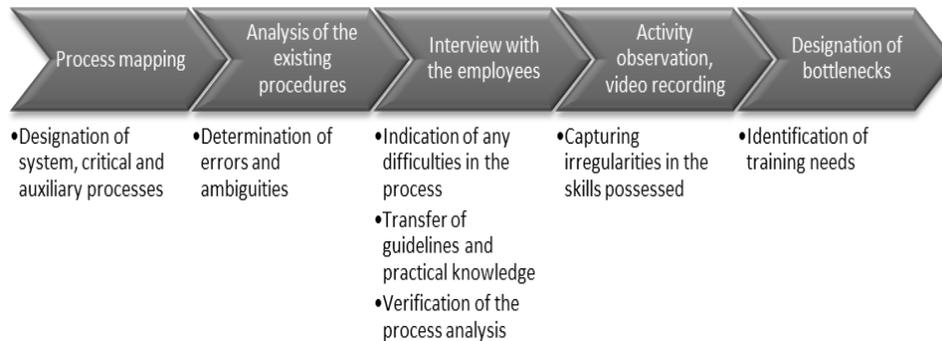


Fig. 2. Training needs identification process diagram

In order to accurately determine the training needs, first, a complete identification of the process which training is to concern, should be made. The process maps completion, including the system, critical and auxiliary processes identification, may be facilitated by the existing procedures, educational materials or instructions. The map of process should include all the activities and resources used to perform the operations, which are the subject of the training. A correctly completed map allows to pre-determine the difficult processes connected to the skills learning. A basic knowledge derived in this way, concerning the described issues will allow for a preliminary analysis of the existing guidelines or instructions. The objective of getting familiar with the existing documentation is an initial indication of ambiguity and vagueness in the wording contained therein. The next step is to conduct interviews with the employees who have some experience in the field covering the scope of the training. Conducting the survey supplemented by an interview aims at obtaining information about the state of the employees' knowledge, their skills level and the general opinion on the information materials regarding the tasks made thereby. Given the experience they possess, they may be able to convey practical information and guidance about the analyzed process. The expected information include detailed further shortcomings of the existing materials, practical advice for other people performing the same process and the indicated most difficult steps or whole steps of the process, to which special attention during the further education should be paid. The next step in identifying the training needs is to follow these activities which the training concerns. Conducting the presentation of the activity performance by people with different experience and skills level should show the most difficult stages in the individual stages of the professional skills teaching. For the activities that are complex or difficult to be observed the video recording of the activity and preparation of a photographic documentation of individual process steps, used tools and equipment to be broadcasted is suggested. The recorded videos and captured images allow for analysis and verification of skills possessed by the employees against the instructions and procedures describing a given process, while checking convergence of the results of the analysis, interviews, questionnaires and observation conducted. The result of such a statement is a set of the process bottlenecks, or the items that to the greatest extent decrease the performance or hinder the acquisition of knowledge. At the final stage of the needs identification the need may occur to distribute these bottlenecks to the individual tasks, which should be supported by the training.

3.2. Training variantivity modeling

Given the problem areas identified in the introduction and the methods' assumptions the following types of training were distinguished:

- Teaching trainings, designed for the new employees.
- *Ad hoc* trainings, including the selected thematic fragments of a given training module.
- Context training, conducted during the work processes,

Table 1 shows the suggested features of the different trainings set based on two-dimensional matrix. The features are organized into the following groups: Time of the training, Place of the training, types of SCOs, method of making available.

Tab. 1. Matrix characterizing the training variants

		Teaching training	<i>Ad hoc</i> training	Context training
Time of the training/ promptness of access to the training	irrelevant	X	X	
	relevant		X	X
Place of the training	home / a place outside of the work	X	X	
	work		X	X
SCOs	text <i>txt</i>	X	X	X
	figure <i>f</i>	X	X	X
	video <i>v</i>	X	X	
	simulation <i>s</i>	X	X	X
	audio <i>a</i>	X	X	
Method of making available	PC	X	X	
	PDA			X
	RFID			X
	AR			X

It should be noted that within the various types of the trainings the content indicated in the table may be variant, e.g., the *ad hoc* training can be implemented in and outside of the place of work, it may or may not have a time limit and different types of SCOs. The presented matrix is therefore the starting point for generating of the subsequent variants representing the final features of the training. Recording of the subsequent variants is done using the decision tables. An example of such a table for the case of the context training is shown below (table 2). Only the variant elements of the table which characterize the training were taken into account. In the case of the context training those are the SCOs and method of making available.

Tab. 2. Decision table, characterized by the context training

If:	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9
<i>txt</i>	X			X			X		
<i>f</i>		X			X			X	
<i>s</i>			X			X			X
<i>a</i>							X	X	X
PDA	X	X	X						
RFID	X	X	X						
AR				X	X	X	X	X	X
Then:									
Variant_1	X								
Variant_2		X							
Variant_3			X						
Variant_4				X					
Variant_5					X				
Variant_6						X			
Variant_7							X		
Variant_8								X	
Variant_9									X

The table shows that the individual features of the training do not include the various forms of presentation of the training content. It is connected with the essence of the training, which aims to provide concise information, depending on the contextual situation. It can be, e.g., a need to familiarize with the instruction manual of the device. That instruction manual shall be then made available automatically in the form of a drawing, through the RFID technology use (Variant_2).

3.3. Acquiring and organizing the knowledge

Acquisition of the knowledge is associated with the flow within the internal and/or external environment of an organization. The specificity of the medical industry is characterized by a high degree of the scientific development, including a wide range of the external factors. This involves the necessity of renewal (update, development) knowledge resources by the medical staff. A specific example are the scrub nurses, who in addition to their knowledge in the area of medical activities are required to improve their skills in surgical techniques, use and maintenance of medical (operational) equipment and tools. This state of affairs is affected by both surgical techniques progress as well as development in the area of science on materials, bioengineering, automation, etc. These areas somewhat inadvertently create the sources and forms of new knowledge acquiring. During the own researches their own sources of knowledge in the process of its acquisition, were defined, as shown in Table 3

Tab. 3. The sources of knowledge in the process of its acquisition

Origin of the knowledge	
ORGANIZATION	ORGANISATION ENVIRONMENT
Staging Accompanying observations Expert panels Database of the surgery recorded in the form of video Photos Electronic Documents Medical documentation	Catalogs Instruction manuals Technical documentation Trainings, conferences, seminars, etc.

Knowledge acquisition process itself is complicated and depends on the “carrier” of knowledge. As the carrier of knowledge are understood the following formally written documents, notes, computer systems as well as a man as an expert.

The knowledge acquisition can take place through codification, *i.e.*, its formal registration in an orderly and structured way in a particular in the specified format so that it could be collected, assimilated and understand. This method of professional skills includes the following methods and tools (including codification) of the knowledge acquisition:

- video recording in the field of the surgery,
- photographic recording of the instrumentation used during the surgery,
- staging of the selected “problematic” activities for example, associated with the assembly and disassembly of the operational tools, computer simulations creation,
- interviews with the employees (experts), recording the knowledge in the form of audio files,
- the formal recording of the procedures in the implementation of surgery,
- analysis of the medical records,
- analysis of the technical documentation,
- analysis of the materials (catalogs) supplied by the medical equipment manufacturers.

It should be noted that the resources obtained in the form of the knowledge elements does not always take the form suitable for provision of a clear and understandable sharing. Therefore, the method of the professional skills improvement based on innovative training techniques supported by the knowledge management, mechanisms includes the need to adequately organize the collected (acquired) resources in order to continue their use.

The ordering is done due to the nature and forms of the knowledge representation, in particular having regard to: text, figures, videos, simulations and sound. This allows a maximum utilization of knowledge through the transformation of tacit knowledge into explicit knowledge and organizes it for its optimal presentation in many variations of making available. The different objects of the knowledge are organized in such a way as to create a structure (network) providing the ability to easily locate and share a variety of configurations of making available. The example of the knowledge resource ordering in terms of the knowledge presentation form and possibilities for their compilation is shown in Figure 3.

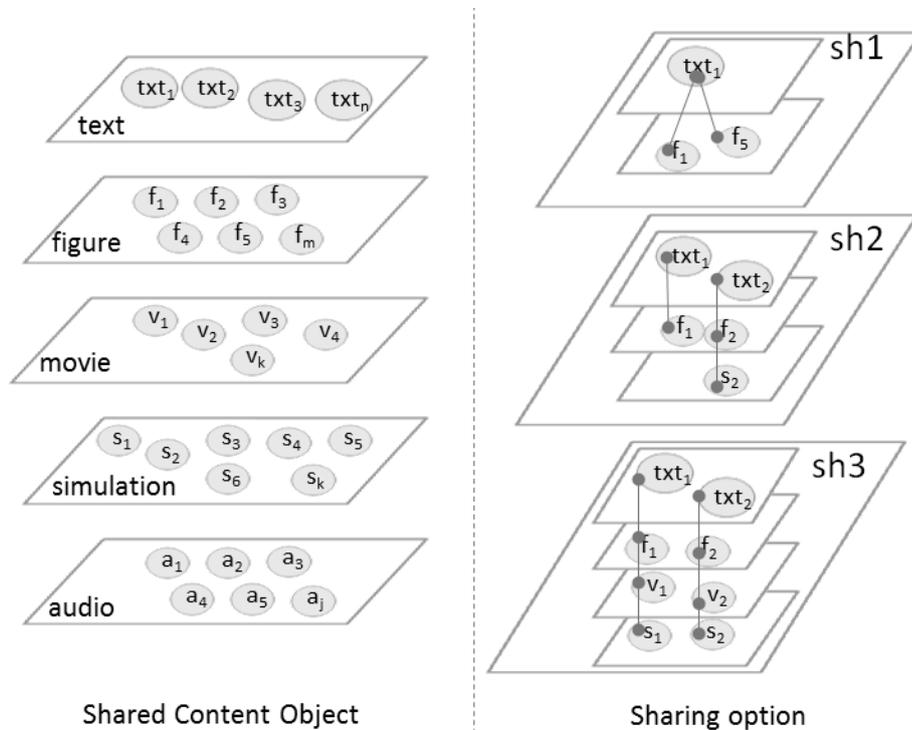


Fig. 3. The example of the knowledge resource ordering in terms of the knowledge presentation and possibilities for their compilation

This approach to organize the knowledge allows for elimination of the repetitive elements of knowledge, while being able to make available the knowledge objects in different contexts and combinations. Depending on the variant adopted taking into account the training needs and method of making available, to describe the problem it can be used for example, the same text, text, combined with a graphic form of the knowledge representation (photos, figures, video), figures, supported by a soundtrack with a problem explanation, etc.

3.4. Sharing the training knowledge

The properly collected and organized training knowledge resources can be made available to the user in a friendly, transparent and comprehensible manner. In order to meet the identified needs, such materials should be provided in two ways, a stationary and a mobile one, enabling delivery from repositories of the contextual resources during the course of the work processes.

This is closely related to the multi variantivity of the trainings and the presented method considers two mentioned scenarios of making available the resources from the knowledge repository.

The first scenario relates to the traditional method of making available the knowledge

(using a desktop computer) through the website where surfing among the knowledge resources is intuitive, via hyperlinks triggered through the active places on the web interface. The example of such the places are the components of the user's menu, the selected graphic elements available on the website, or single words in the text enabling further penetration of the repository resources.

The second scenario assumes a mobile access to the contextual knowledge resources via the RFID technology and the mobile repositories of knowledge. The RFID technology consists in the use of different frequencies radio waves in order to exchange the data between the carriers of information, *i.e.*, an identifier (tag, transponder, label) and a transmitting and receiving device, so-called, RFID reader. In this case, the resources are activated via a code assigned to a particular object, *e.g.*, the surgical tool. These resources are automatically displayed on the monitor screen and refer to that particular object.

As one of the ways to support the sharing of knowledge within the chosen method the augmented reality was also used (called Augmented Reality). The technology is based on the real-world images combined with elements of the virtual world. The glasses are designed for work using the above mentioned technology, and have mounted cameras on their inside displays. The recording camera transmits a real video image stream to the computer that modifies it and sends it to the displays.

At the time of appearance of a programmed tag in the visual field, the animated view of the computer model is added to the real image that reflects the desired action. A fully functional solution is based on the tags defined in the square plan, performed in the resolution provided for by the equipment manufacturer and with the relevant model.

Another method of triggering the information, in addition to tags, is the shapes recognizing method. This gives the possibility of such recognition of the selected fragments of the paper instructions, and thus displaying of supplementary resources assigned thereto such as the computer models and simulations.

4. Example of application of the method for the knowledge-based training creating

According to the adopted method of proceeding, the first step of the training materials development is the process maps completion. The example involves a patient care process since taking him/her to the ward until registering him/her considering the total knee replacement surgery. During the process various operations were analyzed (A) with respect to the participants, *i.e.*, personal function and organizational units. Clarified were the following activities (t) of a scrub nurse, associated with total knee replacement surgery, which are as follows:

- preparation of all the necessary tools, materials, dressings, surgery linen and gloves for himself/herself and the team of surgeons,
- checking if the equipment to be used by the surgeons during the surgery is sterile,
- assisting in dressing by the surgeons of surgical clothes and gloves,
- administering the necessary tools and dressing to the operating surgeons ,
- assisting surgeons if necessary,
- respecting the rules of proceedings with the tools after surgery,
- cleaning tools and preparing them for sterilization,
- cooperating with an auxiliary nurse,
- ensuring rational consumption of materials and equipment.

On the basis of this step it was specified that a particular area which forms the training need is the preparing of the instrumentation for the total knee replacement surgery. This

theme has been chosen because of the resulting information gap. It results from lack of access to the detailed instrumentation assembly instructions.

The procedure for performing the surgery was included to the set of tools, which is a set of the guidelines for both a physician and nurses. Another obstacle in the professional skills improvement is the language barrier. The existing manual is written in English and no Polish translations are available (figure 4).

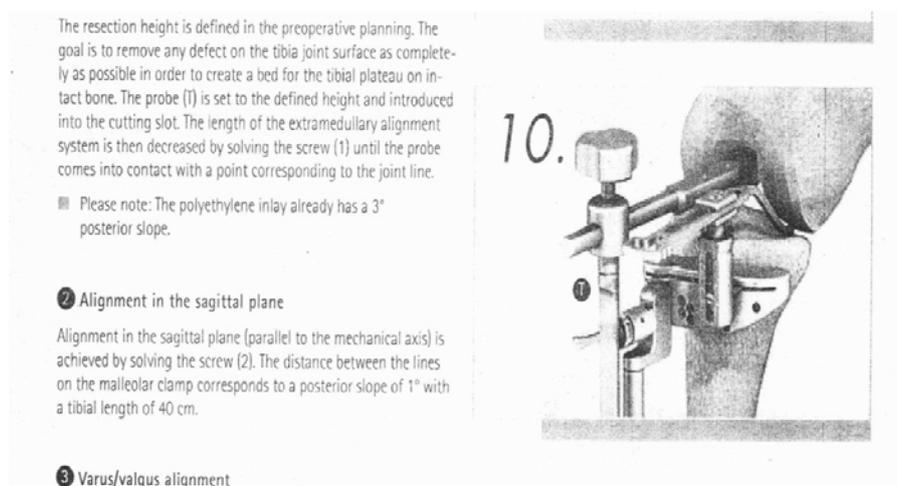


Fig. 4. Fragment of an existing utility routines

The observed information gap has become the basis for the development of training materials in this regard. At the same time, that development is carried out in accordance with the presented method.

The appropriate knowledge resources have been acquired using such methods as:

- staging – the assembly and disassembly tools presentation was performed, which was recorded in the form of an instructional film, photographic documentation of the tool was made.
- analysis of the tools technical documentation.
- analysis of the available instruction manual (procedures) of the instrumentation provided by the manufacturer.
- creating computer simulations of various stages of assembly of the instrumentation.
- development of the audio files, describing the identified stages of assembly.

All the prepared knowledge objects were developed in the scrub nurses' mother tongue. In the next step, they were grouped and ordered in terms of the previously discussed types of knowledge and forms of representation, as shown in the table 4.

Tab. 4. Knowledge resources organized by type and form of knowledge representation

	Procedural knowledge	Declarative knowledge
<i>txt</i>	<ul style="list-style-type: none"> – Text description of steps of the procedure for the tools assembly – Surgical procedure provided by the manufacturer 	<ul style="list-style-type: none"> – Description of location of the elements in the tool boxes – Description of location of the tool box in the operating room
<i>f</i>	<ul style="list-style-type: none"> – The figures show the assembly of instruments in a static “step by step” form, – Informational poster provided by the manufacturer 	<ul style="list-style-type: none"> – Photographs of individual elements of the tool – Location of boxes with the tools shown on the map of the hospital
<i>v</i>	<ul style="list-style-type: none"> – Instructional film about the tools assembly 	
<i>s</i>	<ul style="list-style-type: none"> – Computer simulation of the assembly and disassembly of instruments 	
<i>a</i>	<ul style="list-style-type: none"> – Audio description of stages of the proceedings at assembly and disassembly of individual elements of the instrumentation 	<ul style="list-style-type: none"> – Description of a set of tools for the total knee replacement surgery

The so-prepared materials collected in the form of the thematic knowledge repository allow the sharing of resources in the form of multi-variant training.

The example of how to make available the training materials prepared in terms of the training variant was presented in the figure.

The training is based on the knowledge codified in the form of text, figures. Moreover, these objects are distributed in an electronic version via the web application, which allows surfing among the additional objects of knowledge through the hyperlinks. Figure 5 shows the fragment of the training for the scrub nurses conducted in the static form. The picture included in the training is also a hyperlink triggering an instructional video or computer simulation supplemented by audio description of the ongoing activities.

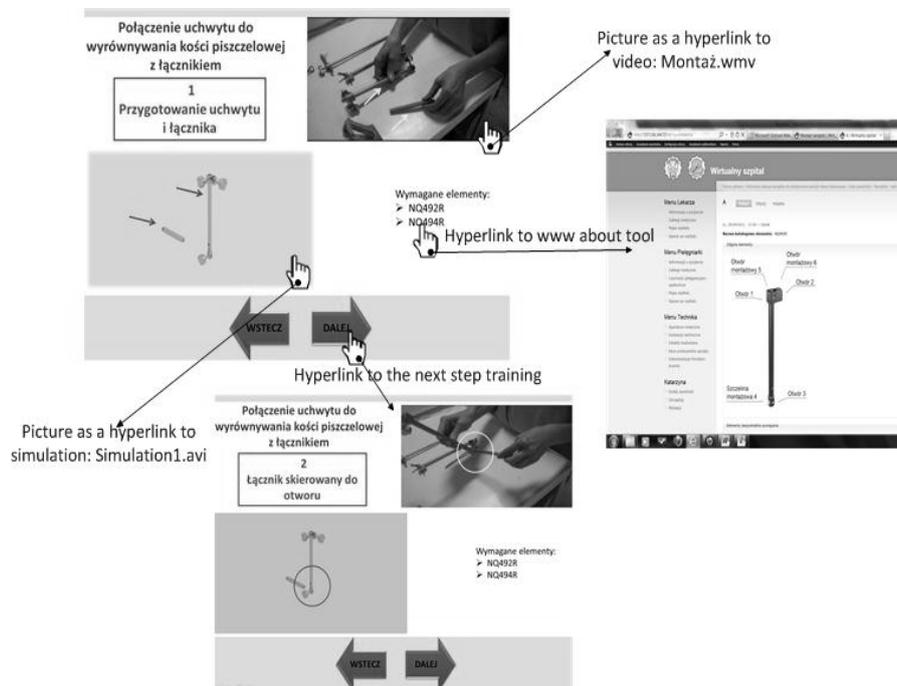


Fig. 5. Fragment of the training for the scrub nurses conducted in the static form nurses

5. Conclusions

The article demonstrates how to prepare the training courses, aimed at the development and professional skills improvement. The accurately selected modeling tools allowed us to organize the activities related to the development of methods of the training needs identifying and organizing the knowledge in a way that they can be repeatedly used depending on the subject, duration, location and other individual circumstances. The further research will be focused on validation of the training method with the participation of medical personnel.

References

1. Bartnicka J., Mleczek K.: A system to improve the working conditions based on the information technology in the Polish health-care units, (ed.) Bojar W., Kaźmierczak J.: Studies and Materials of the Polish Association of Knowledge Management, Bydgoszcz No. 40, 2011.
2. Karwowski W.: Knowledge management (1), in: Occupational safety. Science and Practice, 11 (400), 2004, pp.: 11–14.
3. Alavi M., Leidner DE.: Review: knowledge management and knowledge management systems: conceptual foundations and research issues, MIS Quarterly 25 (1) (2001), pp. 107-136.

4. Gasparetti F., Micarelli A., Sciarrone F.: A web-based training system for business letter writing, in: Knowledge-Based Systems 22 (2009), pp. 287–291.
5. DeLone W. H., McLean E. R.: The DeLone and McLean model of information systems success: a ten-year update, in: Journal of Management Information Systems, 19(4), 2003, pp. 9-30.
6. Nonaka I., Nishiguchi T.: Knowledge Emergence. Oxford: Oxford University Press, 2001.
7. Berge ten T., Hezewijk van R.: Procedural and Declarative Knowledge. An Evolutionary Perspective, in: Theory & Psychology, Vol. 9(5), 1999, pp. 605-624.
8. Valderrama R. P., Leandro Balladares Ocan L. B., Sheremetov L. B.: Development of intelligent reusable learning objects for web-based education systems, in: Expert Systems with Applications 28 (2005), pp. 273–283.
9. Muzio J. A., Heins T., Mundell R.: Experiences with reusable E-learning objects. From theory to practice, in: Internet and Higher Education 5 (2002), pp. 21-34.
10. Kurubacak G.: Building knowledge networks through project-based online learning: A study of developing critical thinking skills via reusable learning objects, in: Computers in Human Behavior 23 (2007), pp.2668–2695.
11. Lee-Kelley L., Blackman D.: Project training evaluation: Reshaping boundary objects and assumptions, in: International Journal of Project Management 30 (2012), pp. 73–82.
12. Carlile P.R.: A pragmatic view of knowledge and boundaries: boundary objects in new product development. Organization Science 13 (4), 2002, pp. 442-455.

Dr inż. Joanna BARTNICKA
 Mgr inż. Katarzyna MLECZKO
 Prof. dr hab. inż. Teodor WINKLER
 Mgr inż. Daniel DĄBROWSKI
 Politechnika Śląska w Gliwicach
 Instytut Inżynierii Produkcji ROZ-3
 Wydział Organizacji i Zarządzania
 41-800 Zabrze, ul. Roosevelta 26
 tel./fax: (0-32) 277 73 92
 e-mail: joanna.bartnicka@polsl.pl
 katarzyna.mleczko@polsl.pl
 teodor.winkler@polsl.pl
 d.s.dabrowski@gmail.com

Artykuł powstał w ramach projektu badawczego promotorskiego pt. „Doskonalenie procesów transferu zasobów wiedzy w organizacji szpitalnej”, finansowanego ze środków Narodowego Centrum Nauki.