

# International E-Learning for Assuring Ergonomic Working Conditions of Orthopaedic Surgeons: First Research Outcomes from Train4OrthoMIS

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**Abstract**—Orthopaedic surgeries are characterized by a high degree of complexity. This is reflected by four main groups of resources: 1) surgical team which is consisted of people with different competencies, educational backgrounds and positions; 2) information and knowledge about medical and technical aspects of surgery; 3) medical equipment including surgical tools and materials; 4) space infrastructure which is important from an operating room layout point of view. These all components must be integrated and build a homogeneous organism for achieving an efficient and ergonomically correct surgical workflow. Taking this as a background, there was formulated a concept of international project, called “Online Vocational Training course on ergonomics for orthopaedic Minimally Invasive” (Train4OrthoMIS), which aim is to develop an e-learning tool available in 4 languages (English, Spanish, Polish and German). In the article, there is presented the first project research outcomes focused on three aspects: 1) ergonomic needs of surgeons who work in hospitals around different European countries, 2) the concept of structure of e-learning course, 3) the definition of tools and methods for knowledge assessment adjusted to users’ expectation.

The methodology was based on the expert panels and two types of surveys: 1) on training needs, 2) on evaluation and self-assessment preferences. The major findings of the study allowed describing the subjects of four training modules and learning sessions. According to peoples’ opinion there were defined most expected test methods which are single choice test and right after quizzes: “True or False” and “Link elements”

The first project outcomes confirmed the necessity of creating a universal training tool for orthopaedic surgeons regardless of the country in which they work. Because of limited time that surgeons have, the e-learning course should be strictly adjusted to their expectation in order to be useful.

**Keywords**—International e-learning, ergonomics, orthopaedic surgery, Train4OrthoMIS.

## I. INTRODUCTION

**O**RTHOPAEDIC surgeries are a specific type of treatment defined by a high degree of complexity. This is reflected by following four groups of resources in operating room (OR): 1) surgical team which is consisted of people with different competencies, educational backgrounds and positions; 2) information and knowledge about medical and technical aspects of surgeries; 3) medical equipment including surgical tools and materials; 4) space infrastructure which is important

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from an OR layout point of view and which determines an organizational and workflow aspects of performing surgical procedures.

The newest achievements in orthopaedic field give the opportunity to perform surgeries with the use of minimal invasive surgeries (MIS) techniques. There are many advantages of performing MIS for patients, such as: reduced trauma to soft tissues; decreased blood loss, less pain and faster recovery; better stability of the prostheses’ components as well as better cosmetic results [1]–[3]. In turn, the situation for surgeons is strictly opposite. Surgeries are marked by a high degree of complexity with physical demands, mental demands, stress and strain, musculoskeletal disorders, work discomfort occurred among surgeons performed both open and MIS treatment [4]–[6]. Taking this as a background, the international project, called “Online Vocational Training course on ergonomics for orthopaedic Minimally Invasive” – Train4OrthoMIS, was defined and carried out by international consortium from Spain, Poland, and Germany. The project and program logos are presented in Fig. 1.



Fig. 1 The logos of Train4OrthoMIS project and funding program

The aim of Train4OrthoMIS is to develop a universal e-learning tool available in 4 languages: English, Spanish, Polish, and German. The course will contain practical aspects of creating ergonomic working conditions when performing MIS of orthopaedy. The idea is to spread the useful ergonomic knowledge to the greatest possible extent among orthopaedic teams which work in different countries and continents.

In this article, there is presented the Train4OrthoMIS research outcomes focused on three areas: 1) ergonomic needs of surgeons who work in hospitals around different European countries, 2) the concept of a structure of e-learning course, 3) the definition of tools and methods for knowledge assessment adjusted to users’ expectations.

## II. METHODOLOGY

The methodology was based on the expert panel sessions and two types of surveys with the use of questionnaires: 1) on training needs, 2) on evaluation and self-assessment

preferences.

The aim of expert panel sessions was to recognize the real problems related to ergonomics in orthopaedic field as well as previous experiences in the field of medical education and then to define the scope, structure and formal issues, such as duration, expected learning results etc., regarding e-learning course.

There were organized parallel expert panel sessions of both hip and spine orthopaedy in Germany, Poland and Spain. Each session was conducted according to one scenario including three substantial points: 1) analysis of the current courses in ergonomic area (if any) with identification of strengths and weaknesses of them; 2) analysis of the areas of knowledge required for conducting MIS in hip and spine orthopaedy and particularly with respect to improvement of ergonomics; 3) identification of requirements for adequate training material on ergonomics applied to MIS of hip and spine. Each session outcomes were gathered and aggregated in order to formulate the structure and scope of questionnaires for surgeons as well as to define universal requirements for e-learning course.

In order to obtain detailed and quantitative data provided by potential users: orthopaedic doctors and students, a survey with the use of questionnaire was conducted. Particularly the aim of the survey was to get knowledge about preferences regarding e-learning course on ergonomics in two areas: MIS of hip and MIS of spine. Hence, there were two kinds of questionnaires: one intended for hip orthopaedists and second for spine orthopaedists (the questionnaires are indicated as QH and QS respectively). However, the questionnaire structure and substantial questions were similar and included 6 sections: 1) personal data; 2) experience in minimally invasive surgery; 3) course features; 4) training expectations and preferences; 5) problem ergonomics; 6) needs of training contents.

One of the important elements of the course is knowledge verification (evaluation and self-assessment) of students. The forms and methods of such verification should be adjusted to training content and they should verify the students' knowledge in reliable way. On the other hand, the assessment methods should be attractive and encourage potential students to join e-training. Hence, the aim of the next survey was to get knowledge about preferences of people on ways and techniques of evaluation and self-assessment. These preferences will be the patterns for creating the evaluation methodology of Train4OrthoMIS course. The questionnaire was performed among respondents with following characteristics: 1) respondents were active people when it comes to gaining knowledge; 2) they were also participants of different kind of degrees studies; 3) they were professionally active or prepared for professionally working; 4) they possessed knowledge about usability of e-learning platform. The questionnaire was divided into 6 sections: 1) personal data; 2) people's preferences on the ways for knowledge verification; 3) people's preferences on the way of partly knowledge verification e.g. each time after lesson, section; 4) people's preferences on the way of final knowledge verification i.e. exam in time restriction; 5) an opinion if using non-standard forms of evaluation (different types of quizzes)

have an impact on attraction of e-training; 6) an opinion if the presence of favoured evaluation forms within the e-learning course (including the final exam) would have an impact on the decision about joining e-training.

All questionnaires' outcomes were processed with the use of descriptive statistics methods.

### III. RESULTS AND DISCUSSION

#### A. Expert Panel Sessions Results

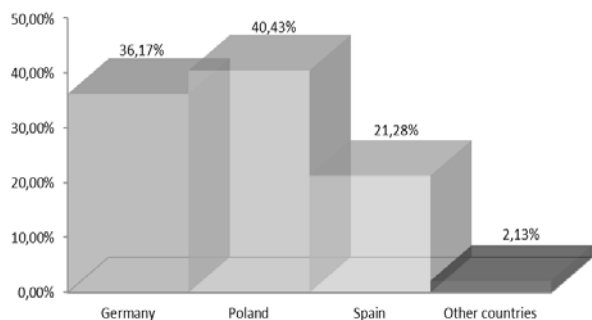
The experts, who took part in sessions, were considering ergonomic aspects of performing orthopaedic surgeries from different perspectives, possessing different experiences and views on orthopaedics working conditions. Hence we obtain the comprehensive information on the needs, interests and concerns when it comes to ergonomics. As a result, a preliminary course structure was prepared and included into questionnaires QH and QS to verification. Particularly this proposed structure is a compromise between the experts' opinions and in result identical for hip and spine orthopaedy. The main points are following: 1. Introduction to Ergonomics. Basic concepts. 2. General aspects of ergonomics in the field of orthopaedic surgery. 3. Types of currently marketed instrumentation. Utility, type of surgery and the latest news. 4. Ergonomics and patient positioning in orthopaedics surgery. 5. Ergonomics related to furniture and surgical equipment in orthopaedic surgery. 6. Ergonomics related to orthopaedic surgical instruments. 7. Surgeon postural ergonomics. 8. Ergonomics related to the position of all the medical staff in the operating room. 9. Simple ergonomic protocols according to the type of surgery to improve posture and prevent disorders. This structure was included into the questionnaire on training needs as a proposition of training content to verification.

#### B. Questionnaire on Training Needs

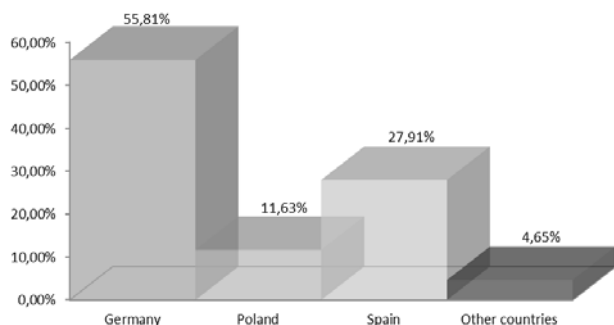
As mentioned, the questionnaire was divided into two kinds of respondents: MIS orthopaedists of hip (QH) and MIS orthopaedists of spine (QS).

Regarding QH, a total of 41 questionnaires were gathered among professionals, 40 in Europe, and 1 in worldwide. Most of respondents were men, almost 86%. A similar questionnaire research was realized for spine orthopaedist. Taking into account QS, there were obtained 23 questionnaires, where 21 were from Europe and 2 from worldwide. Most of respondents were also men, almost 82%. The detailed information about the national structure of respondent of both surveys is presented in Fig. 2.

The reliability of survey outcomes and definition of real ergonomic needs while performing orthopaedic surgeries depends of respondents' experiences in this field. In Fig. 3, there is presented the structure of respondents regarding years of experiences in MIS of hip (Fig. 3 (a)) and MIS of spine (Fig. 3 (b)).

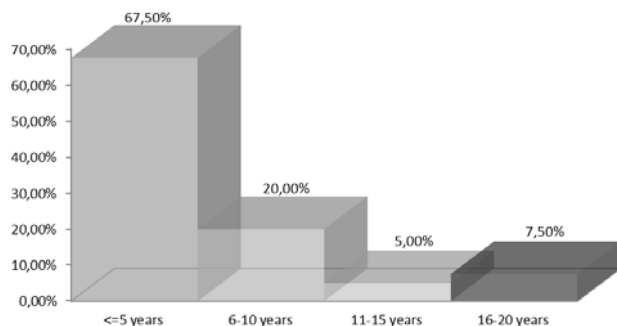


(a)

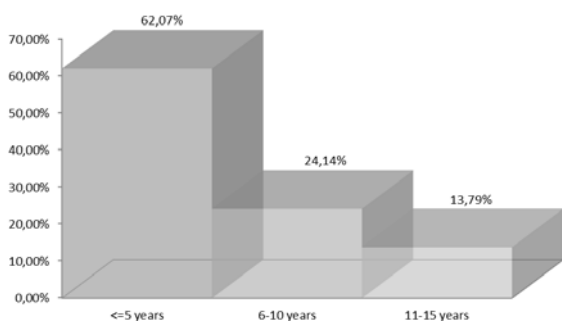


(b)

Fig. 2 The national structure of respondents of (a) QH, (b) QS



(a)



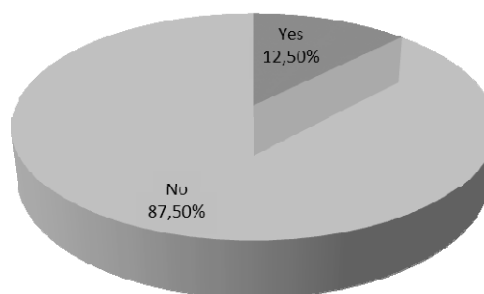
(b)

Fig. 3 Years of respondents' experience in MIS of (a) hip, (b) spine

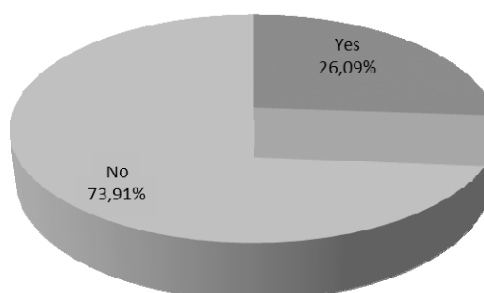
The majority of respondents of QH and QS have indicated less than 5 years of experience in MIS of hip and spine respectively. However, it should be emphasized that MIS techniques are relatively a new approach to surgery in

orthopaedic field and have been still developed. Therefore, the conclusion can be formulated that it is the appropriate time for simultaneously defining the ergonomic goals and teaching the new MIS generations of orthopaedic surgeons about ergonomic rules. On the other hand even a few years of experience gives practitioners the relevant knowledge about all aspects of performing surgeries and hence about ergonomic problems associated to them. The most important ergonomic problems which were indicated by surgeons of both specialties hip and spine is static/awkward body postures and then repetitive movements, the position of monitor and microscopy, instrumental learning difficulty time, the position and height of the table inadequate surgery. Such working conditions implies health ailments among responded surgeons, the most common of which are neck pain, thoracic and lumbar pain, fatigue and musculoskeletal stress, and then stiff neck, fatigue in the legs and feet or mental fatigue and headache.

The necessity of creating training tool in ergonomics is the more important that the great majority of respondents of both surveys (QH, QS) declared no trainings related to ergonomics in the last two years, what is shown in Fig. 4.



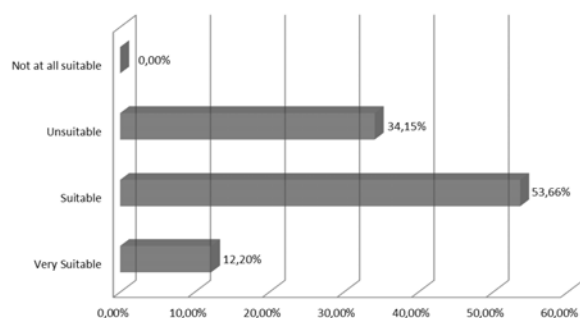
(a)



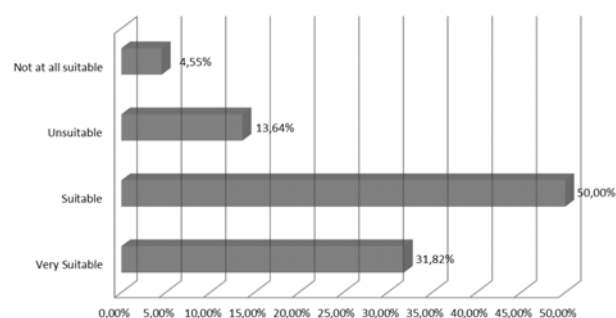
(b)

Fig. 4 Have surgeons received any training related to ergonomics in the last two years according to (a) QH, (b) QS

Because the ergonomic courses are not obligatory in educational paths in many countries and due to limited free time of surgeons, the form and content of ergonomic courses should encourage them to join training. Online courses seem to be the appropriate form of teaching in this sense. This opinion corresponds with surgeons' expectation. The vast majority of respondents (almost 66% of QH and 82% of QS) claimed that e-learning course is suitable or very suitable for professional training. (Fig. 5)



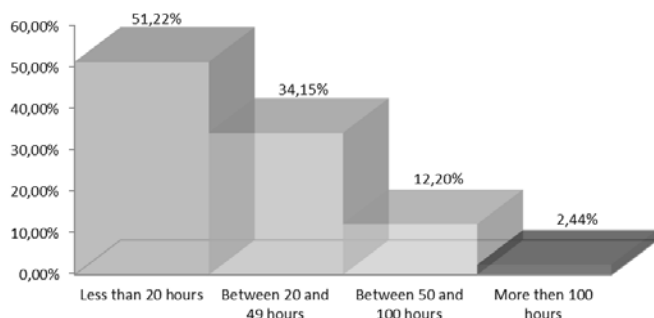
(a)



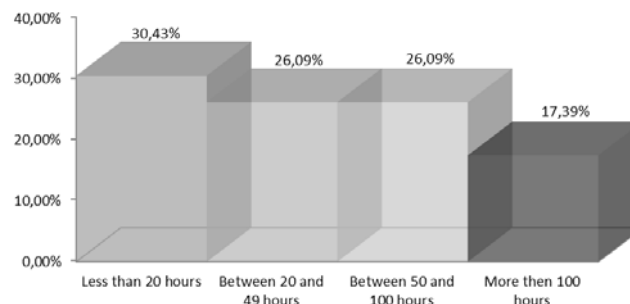
(b)

Fig. 5 The surgeons' opinion about appropriateness of online ergonomic training of (a) hip, (b) spine

However, some of surgeons are not convinced about adequacy of online form for a course. It is probably connected with the necessity of learning practical skills, what is more challenging without workshop classes. The vast majority of respondents of both questionnaires highlighted that training contents must be focused on practice, increase the skills and be useful for the job. On the other hand and taking into account the above mentioned preferences, the possibilities of information technologies, like computer simulations, video lessons, interactive games, provide the new ways of putting practical aspects into e-learning process. In the same time, the international group of respondents agreed in majority that the course should be quite short: it means less than 20 hours for QH (Fig. 6 (a)) and less than 20 hours or between 20 and 49 hours for QS (Fig. 6 (b)).



(a)



(b)

Fig. 6 The preferred duration of e-learning course according to (a) hip orthopaedists, (b) spine orthopaedists

Summarizing the data obtained from QH and QS there were formulated the final version of scope of e-learning course on ergonomic which contains all important aspects of creating healthy and ergonomic working conditions in operating room. The main sessions, which are included into four different modules, are following:

- Ergonomics: concept, fields of application in surgery and problems related with the lack of ergonomics.
- Ergonomics studies and technologies in MIS surgery.
- Ergonomics guidelines for orthopaedic surgery.
- Introduction to hip/spine surgical procedures.
- Ergonomics considerations for selected procedures.
- New surgical approaches, tools, and technologies.
- Operating room setting and environmental conditions in hip/spine surgery – case studies.

The topics and contents are defined in such a way that they will be focused on practical aspects of performing surgeries and hence meet the needs articulated by international group of respondents.

### C. Questionnaires on Evaluation and Self-Assessment Preferences

As signaled the knowledge verification of e-learners should be adjusted to training content and be attractive encouraging them to learn and participate in evaluation process.

E-learning platforms offer different kinds of evaluation and self-assessment methods which can be used under any level of e-learning course. These methods are divided into two main groups: the first group includes traditional/classical methods like extensive written answer, e.g. definitions, theories, thesis etc. as well as single or multiple tests and second group includes modern assessment methods like quizzes: "True / False", "Link elements", "Fill in the gap", Quiz of "Crossword", "Put in right order", etc.

There were gathered 184 questionnaires about e-learners preferences on knowledge evaluation tools. The representatives of men gender were the majority group of respondents (111 persons), when the female respondents were 72 persons. Fig. 7 presents the percentage gender structure in the research and the Fig. 8 the percentage age structure.

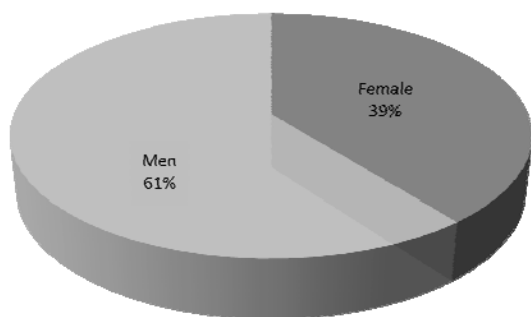


Fig. 7 Gender structure of respondents taking part in the survey on evaluation and self-assessment preferences

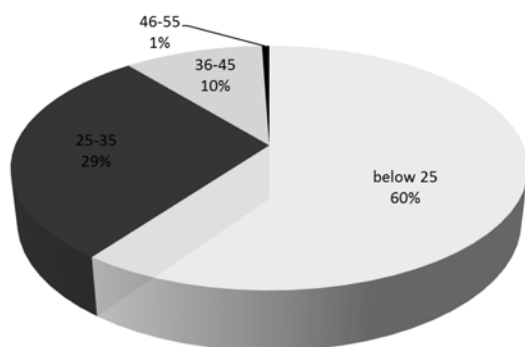


Fig. 8 Age structure of respondents taking part in the survey on evaluation and self-assessment preferences

Taking into account the number of respondents as well as gender and age structures it can be concluded that the research is statistically significant.

For the vast majority of respondents, the written way of knowledge verification is most appropriate (131 persons). Only 23% of respondents claim that oral knowledge verification is the best option. The respondents do not have decided opinion about the presence of a teacher during examination. This aspect of knowledge verification is not important for most students. Fig. 9 presents the respondents' opinions about this subject.

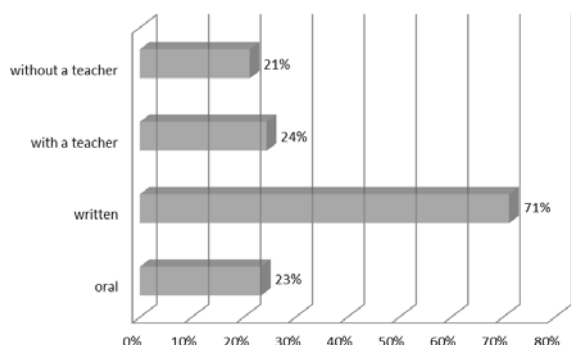


Fig. 9 Preferences on general ways of knowledge evaluation

Taking into account the Train4OrthoMIS training structure, which is consisted of Modules and Sessions, there were assumed that knowledge verification can be divided into partly

and final version of tests for students. Hence there was recommended to know respondents' opinion about evaluation methods used within e-learning courses. The group of respondents could choose both classical and modern methods of knowledge verification.

In Fig. 10, there is presented the summarised data showing preferences about evaluation techniques possible to be used in Train4OrthoMIS course regarding partly knowledge verification.

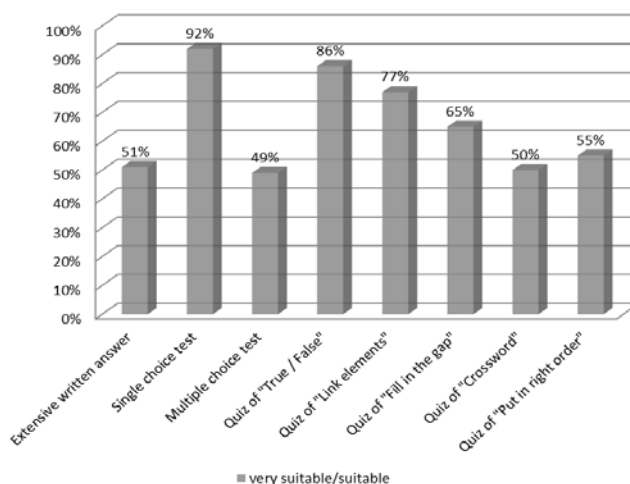


Fig. 10 Preferences of the way of partly knowledge verification

Summarizing the respondents' opinions it can be stated that there are different assessment of evaluation forms which are acceptable for students. The most desired form is classified as classical and it is single choice test. Other classical forms like extensive written answer or multiple choice test is largely considered as improper. Among modern forms of evaluation, the most popular are two quizzes: "True or False" and "Link elements". The rest forms of quizzes are evaluated by respondents non-explicitly. It means that people elevated on average of half for and half against the other kinds of quizzes (in this conclusion the quiz "Fill in the gap" is also included with 64% of answers as suitable and very suitable).

Regarding final evaluation, the distribution of respondents' preferences was similar to previous outcomes, what is shown in Fig. 11.

Most of respondents assessed quizzes as positive side of e-training, where 67% of them claimed that quizzes can make e-training more attractive and for 40% of them using quizzes can increase the motivation to learn (Fig. 12).

The way of final examination of students is important for them. According to 67% of respondents, the presence of favored evaluation forms has rather or definitely impact on the decision of joining e-training. The respondents' all answers are shown in Fig. 13

Based on the survey results, it can be concluded that knowledge evaluation and self-assessment methods within e-training course are important for students and can be even a criterion of joining e-training.

The respondents have similar preferences about knowledge

verification forms for partly and final examination. They are included to both methods: standard and non-standard (different kinds of quizzes). The highest rate is for single choice test and right after quizzes: "True or False" and "Link elements".

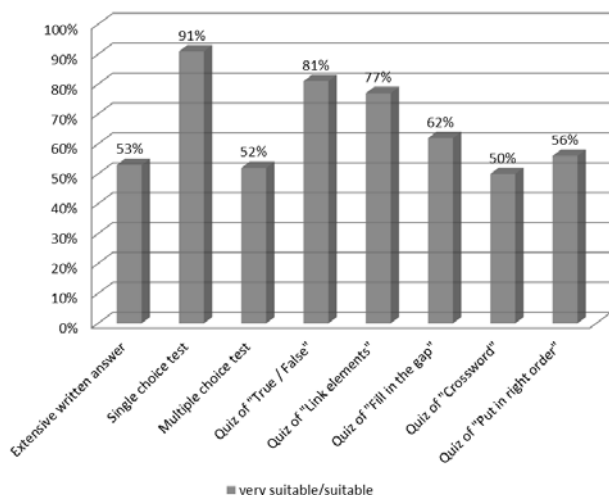


Fig. 11 Preferences on the way of finish knowledge verification

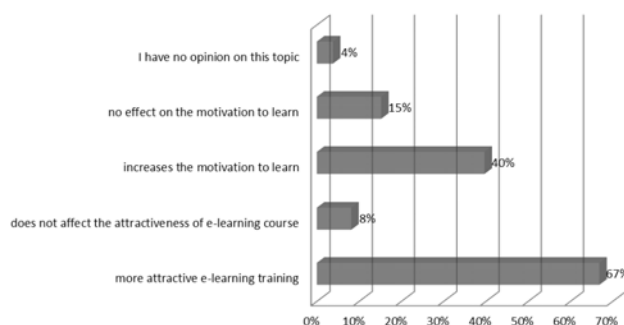


Fig. 12 Respondents 'opinions about non-standard evaluation forms

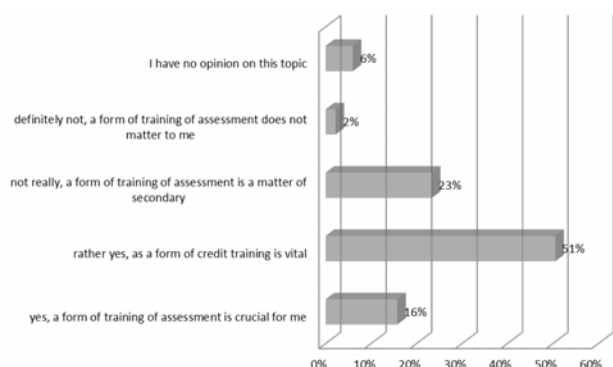


Fig. 13 Respondents 'opinions about influence the training evaluation forms on joining e-course

#### IV. CONCLUSION

The research findings obtained by expert panel sessions and two different surveys give the opportunity for developing a universal and international e-learning course on ergonomics. In particular, the study outcomes made it possible to recognize

the ergonomic problems while performing orthopaedic MIS on international level and hence to complete formative e-learning content according to real surgeons' needs. The results showed that e-learning technique is preferable or accepted even if the learning contents must improve practical skills of surgeons. In addition, the study indicated the classical evaluation methods as most appropriate. More sophisticated quizzes, like crossword, can be only a supplementary way of self-knowledge evaluation.

#### ACKNOWLEDGMENT

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