S-K-S SYSTEM FOR LIFELONG EDUCATION OF WELDERS

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Abstract:

The S – K – S system for lifelong education of welders is directed towards welders and welding operators as basic holders of quality in welding profession. The execution, and at the same time the quality of a welded joint depends on the welder or the operator, on their knowledge, skill or stability to perform in real conditions. It is for this reason that the S – K – S system is based on development and maintaining of three fundamental quality pillars in the execution of welded joints: Skills – Knowledge – Stability.

Skills are connected to welding technique and practical ability, *Knowledge* to welding technology and basic theoretical knowledge in welding, and *Stability* to the psychophysical state of welders. The basic guide to the system is the harmonized document IAB-089r4-12 EWF/IIW Guideline European/International Welder: Minimum Requirements for the Education, Examination and Qualification of Welders.

The logistics of the system are we-learning and other modern IT technologies available to everyone. The system characteristics are: uniformity, quality, continuity, compatibility, flexibility, dynamics, openness and availability.

S-K-S SUSTAV ZA CJELOŽIVOTNO OBRAZOVANJE ZAVARIVAČA

Ključne riječi*: zavarivač, zavarivanje, edukacija, VWTS, trening, znanje, vještina, stabilnost, cjeloživotno obrazovanje, istraživanje*.

Sažetak:

S – K – S sustav cjeloživotnog obrazovanja zavarivača usmjeren je na zavarivače i operatere zavarivanja kao temeljne nositelje kvalitete u zavarivačkim poslovima. O zavarivaču ili operateru zavarivanja, njegovom znanju, vještini i stabilnosti u realnim (stvarnim) uvjetima ovisi izvođenje, a samim tim i kvaliteta zavarenog spoja. Iz tog razloga S – K – S sustav temelji se na razvoju i održavanju tri temeljna stupa kvalitete u izvođenju zavarenih spojeva: *Skills – Knowledge – Stability.*

Pri tome se *Skills* povezuje s tehnikom zavarivanja, *Knowledge* s tehnologijom zavarivanja a *Stability* s psihofizičkim stanjem zavarivača. Osnovni vodič sustava je harmonizirani dokument IAB-089r4-12 IIW Guideline International Welder: Minimum Requirements for the Education, Examination and Qualification. Logistika sustava su we-learning i moderne IT tehnologije dostupne svima. Karakteristike sustava su: unificiranost, kvaliteta, kontinuiranost, kompatibilnost, fleksibilnost, dinamika, otvorenost i dostupnost.

1. INTRODUCTION

A four - year research and pilot program helped come about an interactive training system for welders called S –K - S (*Skills-Knowledge-Stability*) conceived on modern educational technologies, starting from the man: student - welder and professional - welder.

SKILLS: stand for acquisition of skills, i.e. mastering of welding techniques.

KNOWLEDGE: stands for knowledge acquisition, i.e. mastering of welding technology.

STABILITY: in the welding line of work represents the capability of frequent repetition of quality welds under demanded technology using the demanded technique in the demanded period of time on one's own or under supervision. All aspects of welder training were taken into consideration in the scope of research and pilot program - pedagogical and didactic, as well as methodological and psychological. Naturally, all this is accompanied by appropriate teaching materials, aids and technology.

Curriculum pedagogy was taken as the pedagogical basis. Goal of this curriculum is acquisition of competencies by the individual – the welder. The applied teaching principle was the one directed towards the individual. Structured and modular model was chosen as a teaching process model. Namely, in the welding line of work, such model is closely connected to EQF and provides the necessary horizontal and vertical passageway.

Methodical approach for developing the competence or learning how to learn is the hybrid learning based on different combinations of classical face – to - face teaching and learning by using Internet and various other technologies (such as: audio, video, etc.) with the purpose of creating a learning environment that is more effective and acceptable (enriched) for the participant.

Starting from the fact that learning is interaction in its wider sense and that social contacts are a very important link in education, we - learning system was chosen to emphasize this need. Social interaction between participants was thus intensified, and use of social networks (primarily Facebook) and e-mail reinforced the communication channels and raised the quality of education.

Further text will explain in more detail the use of modern teaching materials, aids and technologies during the conducted research and pilot program.

2. THE S–K–S SYSTEM CONCEPT

The S – K – S system concept was shown at figure 1.

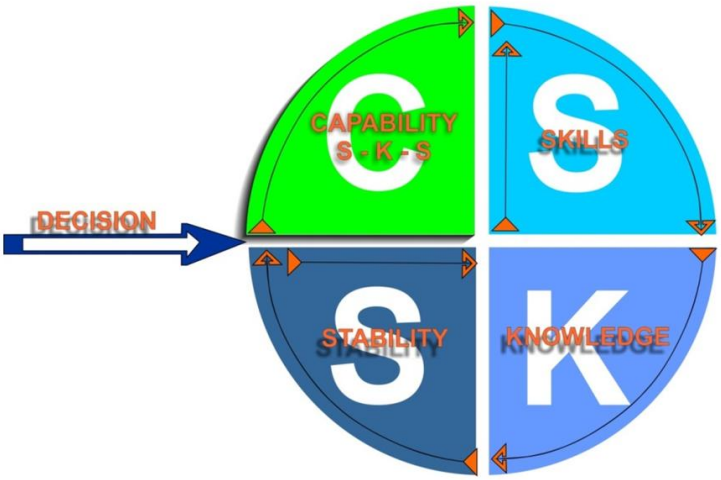


Figure 1. *Outline of S-K-S system*

The system is directed towards welders because they are carriers of quality in welding. Manual welding is specific technology where following aspects become prominent:

- welder's skill in mastering the welding techniques
- welder's knowledge expressed through guiding the welding process on the spot, and
- stability expressed through the psychophysical component visible through a disciplined guidance of the process according to the WPS, through aerobic capability and precision in execution of technical elements.

For that reason, the basic elements of the S – K – S system are: skills, knowledge and stability.

2.1 S-K-S system - SKILLS

Practical assignments for trainees are divided into two types: virtual (40%) and real (60%). Virtual assignments are set by the mentor by designing the curriculum and determining the minimum threshold required for going to a higher level. Real assignments are defined according to the already mentioned IIW-IAB Guidelines (figure 2).

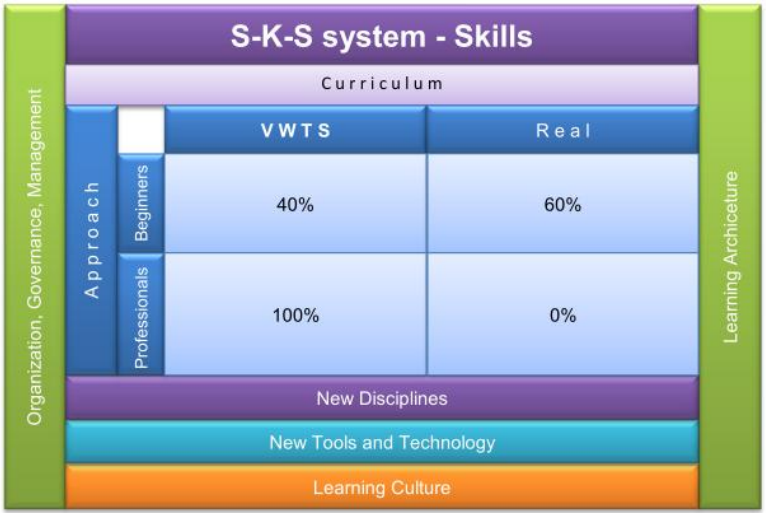


Figure 2. *S-K-S system - SKILLS*

Training of professional welders on virtual simulator (100%) at least once a year, regardless of attestation. Primary teaching material is the VWTS, and teaching aid is the computer.

VWTS makes it possible for the trainer to:

- Manage education according to the target group,
- Define the training content,
- Communicate in different languages,
- Set the difficulty level (threshold),
- Manage the participants with the help of log-in function,
- Save the training data for individuals and groups,

It enables the participant to:

- Obtain basic information on different welding topics,
- Learn everything on different welding positions,
- Get information on current training contents and assignments,
- Track their training progress at any time,
- Check for improvement possibilities with the help of playback option,

The results are outlined through:

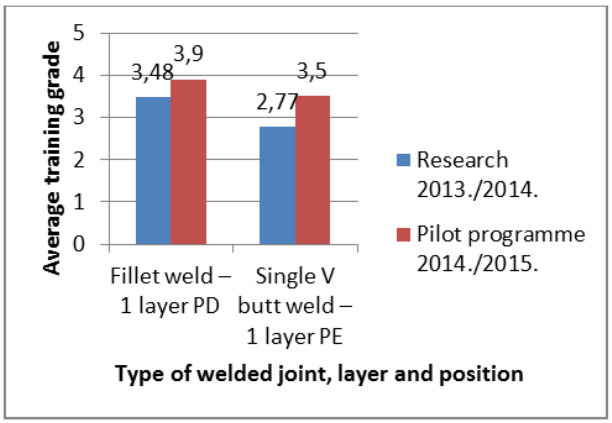
- digital analysis of welding technique,
- graphic outline of the welded joint,
- display of results of each participant and ranking within the group on the screen,
- acoustic information and notifying when making mistakes during welding,
- training information is saved and automatically archived,

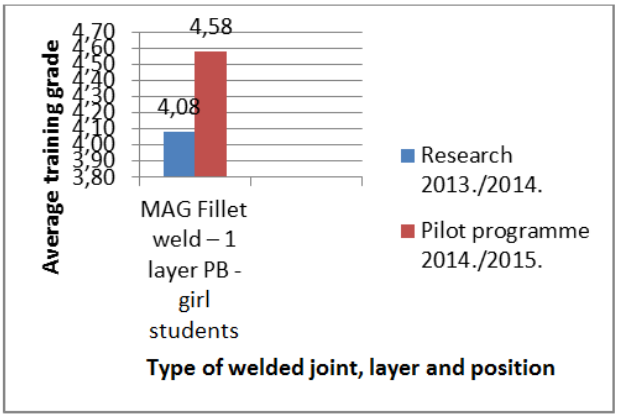
Advantages of using VWTS:

- the possibility of training anywhere, anytime,
- completely ecological training,
- reduced cost of training,
- higher motivation of participants,
- learning through serious games,

- faster and more precise feedback and training results.

Here are some diagrams from the conducted research and pilot program:





2.2 S-K-S System - Knowledge

Theoretical system of assignments is of thematic character, and it is solved by the students in cooperation with their mentor and presented to other students in the classroom or with the help of media. S-K-S System – Knowledge scheme is shown at figure 3.

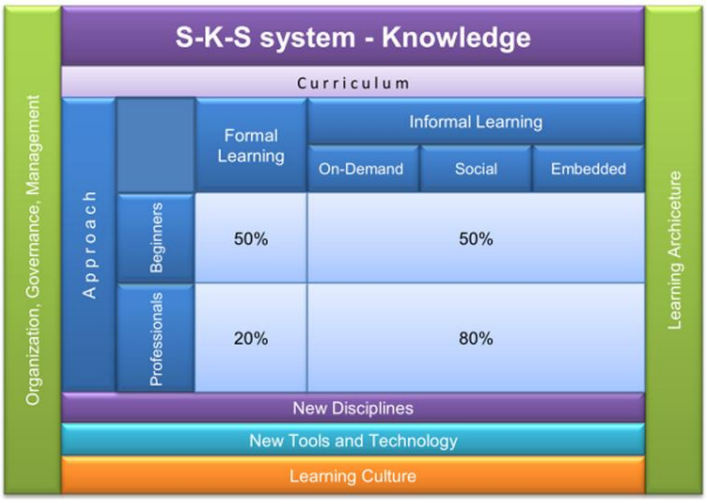


Figure 3. *S-K-S system - KNOWLEDGE*

Basic teaching materials (learning sources) for particular types of informal and formal learning are:

On-Demand learning (mobile as an enabler):

- Welding learning Portals
- Search
- Books
- Videos
- Learning Portals
- Job Aids

Social learning (mobile as an accelerator):

- Wikis
- Blogs
- Forums
- Communities of Practice
- Facebook
- Mail

Embedded learning (mobile as a transformational opportunity):

- Games
- Applications
- Feedback
- After Action Work
- Quality circles

2.3 S-K-S system – Stability

The teaching material is video with anticipated exercises for raising the level of psychophysical state of welders. Teaching aid is the mobile or tablet. S-K-S System – Stability scheme is shown at figure 4.

Figure 4. *S-K-S system - STABILITY*

Role of the psychophysical training is to raise the welder's efficiency in such a way to enable them to very specifically repeat certain moves many times in specific body positions, and to have a steady hand while doing that. In addition, this type of training helps the welder achieve stability – to be able to transfer the accomplishments from skills and knowledge training in interaction with conditioning to his work place, i.e. to optimize their work and achieve the results systematically, and not by chance.

2.4 Characteristic of the S–K–S system

Characteristics of the system are: uniformity, quality, continuity, compatibility, flexibility, dynamics, openness and availability.

Uniformity:

The system is based on the harmonized document IIW: IAB-089r4-12 IIW Guideline International Welder: Minimum Requirements for the Education, Examination and Qualification.

Quality:

Quality is assured through two dimensions: personal and institutional.

Continuity:

The concept of lifelong education of welders ensures continuity in skills and knowledge and at the same time raises the level of their stability.

Compatibility:

The system is compatible with all welding processes and all VWTS.

Flexibility:

The system is flexible because it allows for adjustment of trainings to the demands of individuals or organization for who it is carried out, without the negative influence on quality.

Dynamics:

Individuals and organizations chose their own dynamics according to their own assessment.

Openness:

The system is open to trainees, professionals, hobby welders and the business sector. It is also open for all the new technologies and techniques that will in any way contribute to progress in welder education and to raising the quality of welding in general.

Availability:

Upon the completion of the project, the system is going to be available to all interested parties without any restrictions whatsoever.

2.5. Diagram outline of the S-K-S system

Diagram outline of the S-K-S system is shown at figure 5.

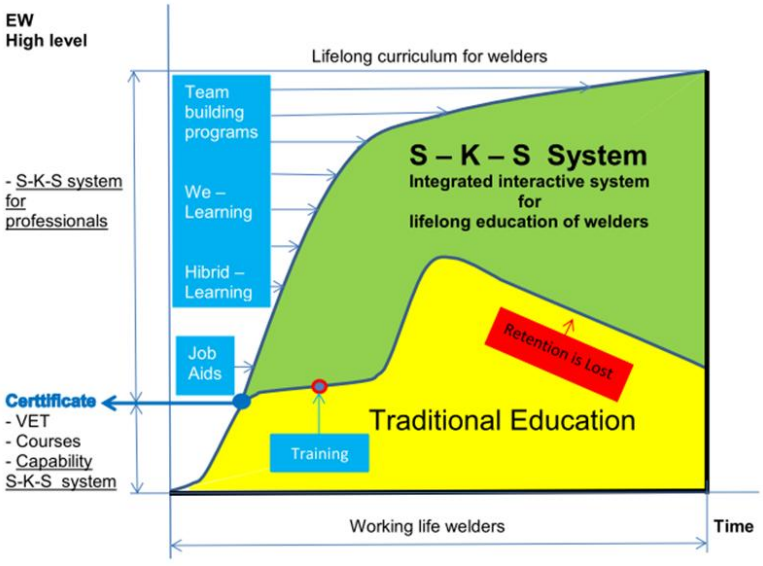


***Figure 5**. Diagram outline of the S-K-S system*

The experience of the industry sector, the conducted research and pilot program over the period of 4 years have proven that by implementing the S-K-S system in its entirety, the efficiency and the quality of welders keep increasing throughout their entire professional life.

3. CONCLUSION

The S – K – S system emerged from the needs and demands of the European labor market and harmonization of welder competencies at European level. It also accepted the need for lifelong education of welders that followed the speedy and dynamic development of new materials and technologies in the area of welding. For this reason, a system was designed that would cover the needs of all welders, from the start of their education until the end of their professional career. All throughout this period, the system covers three important elements in education, development and maintaining of welder competencies: knowledge, skills and stability (and among other things, health).

The S-K-S system is using modern teaching materials, aids and technologies in its application. Such approach is necessary in today's world because of rapid and dynamic development of technologies. Research and pilot program have demonstrated that consumers of new technologies are people of all age categories and that many of them possess enviable level of competence in usage of IT technologies acquired through informal education. Young people are definitely dominant here.

Pursuant to this, those dealing in education need to create such an environment that they can, by using modern teaching materials, aids and technologies, enter the world of consumerism on the Internet. They should look into the structure of participants' interests and adjust the conditions to the modern way of learning and communicating. In this way, learning and communicating at all levels will be made easier. Experience from this project contributes to the fact that it is necessary to offer welders verified e-learning materials adjusted to mobile devices, but also all types of information they would be able to use anywhere, anytime. Likewise, it is necessary to initiate and develop communication among welders at European level.

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