Research Article

# Piloting the ECHO e-Skills and Training Toolkit

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A B S T R A C T :

Besides many benefits, ICT technologies are faced with cyber threats. Organizations of today, therefore, face many challenges that require technical, situation awareness, and problem-solving related e-skills from a wide level of organizational actors. Business survival depends on how well an organization can implement new IT and take advantage of the opportunities offered by this new IT. Cybersecurity is a pressing issue in modern society. It affects businesses, personal lives, and critical infrastructures. There is a growing need for proficiently cyber-trained personnel to protect society and its organizations and systems.

The ECHO E-skills and Training Toolkit was piloted with a team of higher education business ICT teachers. First, the team supervisors chose and valued the most relevant Technical, Situation awareness, and Problem-solving related e-skills. These choices were then given to the pilot test group to discuss and adjust. This pilot study shows that the ECHO E-skills and Training Toolkit can be used to benefit any organization that wishes to assess the e-skills of its personnel and training gaps.

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## Introduction

The term skills refer to what a person knows, understands and can do.[1] Skill is a combination of knowledge, experience and ability that enables end users to function well.[2, 3] The complex cyber domain calls for many knowledge, skills, and abilities (KSA), which in this study are referred to as e-skills. Both cyber professionals and people working in information-intensive jobs need appropriate levels of e-skills. Today's employers need digitally intelligent people who not only know how to use, but also innovate and lead the use of ICT systems and solutions. Businesses, organizational communication, and learning have become transformed by the Internet, as modern society is technology driven. People in workplaces interact on cloud based social networking platforms and solutions.

Besides many benefits, ICT technologies are faced with threats, as vulnerabilities in ICT applications and systems may become exploited in ways that require appropriate e-skills from their employees. E.g., in 2020, the Allianz Risk Barometer ranked cyber incidents as the greatest risk threating business continuity. Organizations of today thus, face many challenges that require technical, situation awareness and problem-solving related e-skills from a wide level of organizational actors.

Project ECHO aims to strengthen proactive cyber security in the European Union through effective and efficient multi-sector collaboration. This study pilots the ECHO E-skills and Training Toolkit methodology, which can be used to identify the e-skills that are relevant to cybersecurity. This methodology is designed to be used to assess training gaps. To achieve this the E-skills and Training Toolkit will be assessed with more rigorous testing. This pilot study is an important first phase in its further development. The goal of this pilot study is to provide information on the practical usability of the E-skills and Training Toolkit methodology by validating the toolkit in a real setting. The research question of this paper is 'Can the ECHO E-skills and Training Toolkit have practical benefits to identify cybersecurity related training gaps in organizations?'

## Literature review

The acquisition of new skills is important in keeping pace with technological developments through the introduction of innovative training methods.[1, 4]

E-skills (electronic skills) include the skills needed to use Information and Communication Technologies (ICT) and the skills needed to apply and develop them. E-skills are important for increasing competitiveness, productivity, and innovation, as well as the skills and employability of the workforce, as they apply to all sectors and elements of society by providing ICT users with advanced knowledge and skills.[5]

There is a need to ensure that the knowledge, skills and competencies of supervisors, IT professionals and users meet standards and are constantly updated throughout the lifelong learning process.[6] Researchers [7] have identified technical, situational awareness and problem-solving skills as the main levels of e-skills development among employees. The following sections present the above-mentioned skills in more detail.

### Organizational Learning

It can be beneficial to use ICT promote knowledge management practices,[8] and ICT-implementation is important in building competitiveness.[9] ICT can be applied to improve internal and external flows of information.[10] ICT usage can help companies develop skills that enable them to, even with limited resources, access and absorb state-of-the-art knowledge from external sources.[11]

Knowledge generation and information processing can be used to promote productivity and competitiveness, as ICT can act as a catalyst for organizational learning.[12] However, information systems strategies need to be aligned with other business strategies, so that the development of IT-infrastructures is clear for everyone in the organization.[13]

Leadership support is required to promote positive policies and a sense of readiness, as opposed to being resistant to change.[14] Learning is necessary for organisations,[15] and note an increase in the use of mobile technologies in the education sector have increased.[16] ICT-infrastructures support knowledge sharing in organizations; however, these can be costly,[17] and the lack of skills or competences can hinder learning to use organizational ICT-tools.[18]

### Gaps in Cybersecurity related E-skills

With cybersecurity becoming a pressing issue in modern society by affecting businesses, personal life, and critical infrastructures, there is a growing need for proficiently cyber-trained personnel to protect these systems.[19] Developing general ICT skills (e-skills) becomes necessary in today's modern ICT-oriented society; investing in ICT / e-skills can provide many advantages and cyber competences and that make it possible to protect oneself against cyber threats.[20] In most cases cybersecurity becomes compromised because of inadequate cybersecurity awareness and skills that cause human errors.[19]

Organizations that aim to prepare adequately to withstand threats that can compromise their security and continuity of operations must secure every critical element of their infrastructure.[21] For ICT professionals, the challenge is to become more proficient in analyzing and managing the constantly evolving cyber threats.[22] Without having relevant cybersecurity training, users can rarely distinguish between legitimate requests and a cyberattacks, where social engineering and phishing are the most common attacks that end users usually encounter.[22]

A challenge in implementing cybersecurity training and education in organizations is knowing how to properly provide training that will effectively engage staff (who are not ICT personnel) to practice security awareness and develop their cyber skills.[22] Organizations are recommended to invest in cybersecurity awareness programs and cyber training to deal with cyber threats so that users do not inadvertently leave their company network vulnerable to threat actor.[21]

Cybersecurity education programs teach security concepts with traditional approaches, instead of using experiential learning and interactive.[23] Practical training through network simulated exercises and interactive cyber lab training

can be very beneficial in developing relevant cyber skills in cybersecurity train-ing.[21] Cyber professionals who maintain security need skills and knowledge about the use of analytical tools (e.g., vulnerability analysis or network scan-ning) and computer systems.[24]

## Technical, Situation Awareness, and Problem-solving E-skills

Successful cybersecurity activities call for IT skills in technologies, applications, networking, and infrastructure, coupled with knowledge and skills of IT opera-tions.[25] The importance of identifying relevant cybersecurity skills to ensure that organizations, work roles and individual skills are successfully aligned with each other.[24] Technical and engineering skills seem to be emphasized in the cyberse-curity domain.[26] Important social and organizational aspects that are needed to perform successfully in everyday work-life settings tends to be ignored,[24] as also non-technical knowledge, skills, and abilities (KSA), such as problem-solving, communication and collaboration can be useful.[27]

Cyber professionals need to be able to communicate technical information to non- technical people without,[24] so non-technical KSAs should be integrated to professional development trainings and higher education programs for cy-bersecurity professionals.[27] The need for strong situational awareness skills, with continuing risk assessment skills, for network professionals has been long been noted.[28]

Besides and customer and personal service, and administration and manage-ment, cybersecurity calls for skills in critical thinking, complex problem-solving, monitoring, systems analysis, and coordination, combined with technical knowledge of computers, electronics, telecommunications.[29] Cybersecurity pro-fessionals also need decision-making models.[30] Some suitable backgrounds for future cybersecurity professionals can be information intensive work such as gathering, evaluating, documenting, and recording information, updating, and using relevant knowledge, and solving problems and making decisions.[29]

### Technical skills

Technical skills refer to the specific knowledge and expertise required to per-form complex activities, tasks, and processes related to technologies.[31]

Special expertise in the information systems (IS) field can include hardware, systems and application and software knowledge. These competencies apply to specific applications that can be called technical knowledge and application ex-pertise.

### Situation Awareness skills

One of the non-technical skills related to human factors is situational aware-ness.[32] Situational awareness is based on perceiving, understanding the mean-ing, and anticipating what may happen in the future. Decision-making is based on experience or new knowledge to assess the situation or make a diagnosis or choose a course of action, both in normal circumstances and in emergency sit-uations.[33]

Strong situational awareness skills are one of the classes of non-technical skills needed to make sound decisions. There are three levels of situational awareness: perception of the elements in the environment, understanding of the current situation, and prediction of the future status.[34, 35]

From the perspective of situational awareness skills, the focus is on vision skills, space management, pattern recognition, and data processing and decision-making skills.[36]

### *Problem Solving skills*

Many problems involve an unwanted situation that requires solutions. "Problem solving consists of isolating the cause (s) of the problem and eliminating or at least reducing the effects."[37] Problem-solving requires logical reasoning to process data by means, that problem can be solved efficiently and effectively.[38]

Problem-solving skills can be divided into two skills: observational and critical thinking skills. Observational skills relate to gathering information, comprehending meaning, and interpreting it by identifying central points. Whereas critical thinking skills consist of conceptualising skills, logical reasoning, application skill, analytical thinking, decision-making skill, and synthesising skills.[38]

Employers require problem-solving skills and critical thinking, which include e.g., data literacy, critical reading, and data analysis.[39] The Council for Aid to Education, Inc. (CAE) argues that "problem solving skills are extremely valuable for academic and career success,"[40] making these skills essential and most sought after by employers.[39, 40]

## Method

The case is about using and testing the E-skills and Training Toolkit that is provided by the ECHO project, in a practical work life setting. The E-skills and Training Toolkit was developed during 2020 – 2021. This development was first based on background study of academic literature, which was done in relation to the work done in the ECHO project. An initial concept was first built 'on paper' and this was then digitalized as the E-skills & Training Toolkit v1.0. 388 European recruitment advertisements were analysed to create initial long lists of Technical, Situation awareness and Problem-solving skills. These were then further developed through three rounds of iterations into the current lists, in Table 1, that serve as basis for the E-skills and Training Toolkit.[19]

Based on the analysis of the labour market in United Kingdom, Finland, and Ireland, it was found out which are the most desired e-skills that employers want from their future employers. To determine what competencies are required, information was gathered from job postings in 2021. Data for this study were collected from UK (n= 150), Finnish (n=178) and Irish (n= 60) job vacancies.[41] Scientific publications and articles, as well as lessons learned from previous studies on job advertisements, were used as data collection methods for the study. The long lists were shortened to 15-22 e-skills in three selected sections through 4 rounds of iteration. Technical, situational awareness and problem-solving skills were selected as sections in the ECHO project workshop.

This methodology section provides an overview on the toolkit and how it is used. To identify further develop needs and to discover potential challenges in its usability, the toolkit was presented for a test group for a real e-skills evaluation, which is presented in this case study. The event was observed by the researchers and these observations with received feedback from the participants are presented in the Results section.

### The E-skills and Training Toolkit

The three sections of the E-skills and Training Toolkit are the Technical, Situational awareness, and Problem-solving related e-skills. In every section there is a list of 15 - 22 skills out which the ones important to the team can be chosen (ECHO E-skills and Training Toolkit). These long lists are based on European recruitment advertisements of which they were originally collected[19]. The lists are presented in Table 1.

### Conducting the Pilot Study

The pilot study participants were academic staff teaching in business information technology related degree programmes at a university of applied sciences. The participants represented teaching teams from two campuses, but for the sake of this pilot study they acted as one team. As their work calls for e-skills and they had no prior involvement with the E-skills & Training Toolkit, these teachers were deemed as valid pilot study participants. The pilot study was conducted in conjunction with a team development event, during which the three sections of the toolkit that were competed by the participating team members and their two supervisors. The researchers provided technical guidance but was not part of the validating and goal setting process.

Using the E-skills and Training Toolkit includes two main phases. The first is setting target values for a team. This can be done by the team supervisor. The second phase is the team members' self-evaluation of their skills. This pilot study completed both these phases. The target values of this pilot study were jointly set by the two supervisors of the test team, who chose the skills that they deemed relevant for the teachers in their teams. The supervisors discussed their team's goals and needs and made their choices from the toolkit's lists. This E-skills and Training Toolkit provides three lists of e-skills for supervisors to choose the target values that best correspond to team needs and goals. In this pilot study, the first phase, selecting target values, was conducted before the actual pilot study event, while the second phase, self-assessments, was done during the event. The choices that had been made by the team supervisors were then presented to the respondents for self-assessment. In this phase the participants conducted individual self-assessment of their e-skills using the ECHO E-skills and Training Toolkit. Participants gave their answers by using a random number from 101 to 199 of their own choice instead of their name or initials, so that the ECHO team was not aware or able to discover participants' names or connect them with given answers. No personal data was collected for testing and research purposes.

**Table 1. List of skills in the E-skills and Training Toolkit.**

| Technical skills | Situational awareness skills | Problem Solving skills |
|---|---|---|
| Architecture | Audit criteria | Analytical |
| Automation related | Built-in security | Communication |
| Cloud related | Common security tools | Cooperation |
| Configuration of devices | Critical infrastructure configurations | Coordination |
| Databases | Cyber security training experience | Decision making |
| Development of testing and internal tools | Cybersecurity experience | Documentation |
| HW related | Data protection legislation | Interaction |
| Industrial related | Infection mapping | Negotiation |
| Information system expertise | Information security | Networking |
| Data protection and public sector legislation | Network security | Performance |
| Management related | Pressure resistance | Planning |
| Scrum and agile methods | Privacy protection | Practical |
| Network related | Public sector legislation | Prioritization |
| Programming | Risk assessments | Punctuality |
| Information systems' security | Web app security | Self-driven |
| Optimization and maintenance of solutions | | Service attitude |
| SW related | | Solution-oriented |
| Usability | | Stress tolerance |
| | | Systematic |
| | | Teamwork |
| | | Testing |
| | | Time management |

The 14 participants were divided into three small groups that were each given a chance to contribute to a section of the toolkit. Besides technical instructions, the participants received the toolkit's written instruction to select 5 - 8 skills from each section's list of skills, from the point of view of their team's goals (ECHO E-skills and Training Toolkit).

When a participant gave his or her answer in the self-evaluation phase, only the skills that are chosen and validated in the first phase were shown by the system. In the end team answers were collected and analysed with ECHO E-skills and Training Toolkit.

The pilot study took place in a classroom, where all the participants had equal chance to participate and discuss. Because the team was a group of professional

experts in the field of education and their opinion of common goals was seen important and value adding and after completing the pilot test, the participants to discuss and adjust. This information will help the further development of the tool.

## Results

The results show the concept of the tool is worth further development. Especially, the lists of e-skills will need more work in all three categories. The tool provided results with graphics for every respondent as well as the entire team.

Respondents commented that the toolkit was quite easy to use and that they found the step-by-step guidance provided by the researchers helpful. The researchers noted that the elaborative questions that were asked by the respondents were quite easily answered by the researchers. This would indicate that an organisation that will want to use the toolkit should, for the time being, engage the help of an ECHO-trained facilitator to use the toolkit to identify possible training gaps efficiently.

The participants commented that the most important skills for their work are those that directly enable them to provide relevant education to business IT students. The teacher team that participated to the pilot study was somewhat heterogenous in its tasks and skills, and the pilot indicated that the tool works best when the team is quite homogeneous. The pilot study results show that some of the toolkit skills alternatives and competence skill levels will need to be defined more specifically.

The team graphics that the toolkit provides allow the team supervisors and members analyse and compare the collective skills possessed by the team with the team's target value levels. The graphic provided is shown in Figure 1.

The results of this case study indicate that this toolkit can be used to address cybersecurity related e-skills from a Technical, a Situation awareness, and Problem-solving related viewpoint. This can provide an organization one practical and systematic way to identify some most relevant e-skills gaps.

It was shown that this toolkit (only) provides gaps between measurements of values pre-set by the team supervisor and team member self-assessments. The practical results of this pilot study show that as the results of each measurement are dependent on how focused and though-out these sets of values are. It seems that people may see their skill-levels differently, depending on their personal traits and level of self-confidence.

The tool may permit organisations to focus on what trainings their existing personnel need and guide their recruitment according to the identified gaps in team / organisational e-skills. One finding was that the process where gaps were identified and discussed provided fruitful opinions from the respondents. This helped the team discuss the different roles of team members.

## Conclusions

This pilot study provides evidence from a real work life setting that shows the ECHO E-skills and Training Toolkit can be useful for organisations that wish to

## Average Problem Solving Skills Gap analysis for Team:

☐ Target values
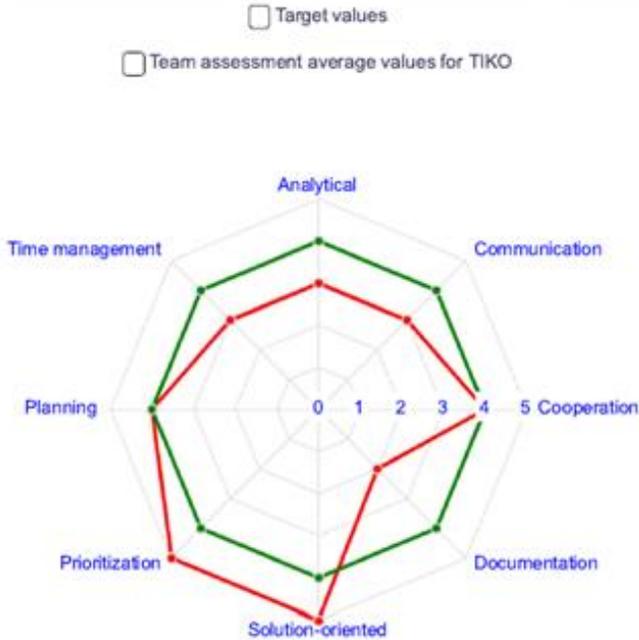
☐ Team assessment average values for TIKO



**Figure 1: Team graphic provided by the E-skills and Training Toolkit.**

assess their e-skills and training gaps. The study also shows that the organisation needs the help of qualified ECHO-trained facilitators to properly use the toolkit.

This toolkit tries to address cybersecurity related e-skills from three specific viewpoints: Technical, Situation awareness, and Problem-solving related e-skills. This pilot study shows that these can provide organizations an understandable and systematic way to identify their most relevant e-skills gaps. An interesting finding was that the process of identifying and discussing about these gaps in itself proved to be very fruitful opinions from the respondents.

This provides one possible structured approach to identify and address needs-based training, recruitment, and development. Organizational users can identify and prioritize Technical, Situation awareness, and Problem-solving related e-skills in a systematic way. Organisations may focus on what trainings their existing personnel need and guide their recruitment according to the identified gaps in team / organisational e-skills. In the future, the toolkit could be further developed to provide recommendations for e.g., suitable professional trainings. These insights can help business operations build their cyber-de-

fences. This assessment can be further developed and leveraged to define appropriate training and recruitment pathways when this methodology enables organisations to address competence gaps to identify related trainings.

One future development could be to keep the e-skills lists updated by, in real-time, using big data searches of relevant e-skills from current recruitment advertisements. Also, the tool could be coupled with trainings searches to identify trainings that appropriately correspond to each individual need. Once the E-skills and Training Toolkit becomes sufficiently tested and approved, some practical applications of the toolkit in business environments could be that managers, educators and human capital specialists may gain useful insights to guide their organisations skills-based training and recruitment focus, plan training content, and help competence building on both an individual and organisational levels.

Comparing pre-set organisational e-skills target values against individual employee self-assessments makes it possible to understand organizational and individual learning viewpoints. This, in part contributes to and expands the overall understanding of societal impacts on organizational cybersecurity, which provides a contribution to both practice and theory.

## Acknowledgements

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