Opinion Paper

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Digital competence in laboratory medicine

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Abstract

Objectives: Even though most physicians and professionals in laboratory medicine have received basic training in statistics, experience shows that a general understanding of data analysis is not yet available on a broad scale. Therefore, data literacy, data-driven decision making, and computational thinking should be implemented in future educational training. To evaluate the state of digital competence among young scientists (YS) in laboratory medicine, we launched a worldwide online survey.

Methods: A global online survey was conducted from 25/05/2022 to 26/06/2022 and was disseminated to YS who are listed in three large networks: YS of the DGKL, the EFLM Task Group-YS, and IFCC Task Force-YS and its corresponding members, covering a base of 53 countries.

Results: A total of 119 young scientists from 40 countries participated in this survey. 80 % did not learn digital skills in their academic education but 96 % felt they needed to. Digital literacy was associated with terms such as programming, artificial intelligence and machine learning, statistics, communication, Big Data and data analytics.

Conclusions: The results of our survey show that more knowledge and training in the area of digital skills is not just necessary, but also wanted by young scientists. A varied learning environment consisting of tutorial articles, videos, exercises, technical articles, collection of helpful links, online meetings and in person bootcamps is crucial to meet the challenges of an international project with different languages, health systems and time zones.

Keywords: artificial intelligence; data science; digital competence; digitalization; skills.

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Introduction

The healthcare sector is changing

Today, we are witnessing the next great technological revolution after industrialization: The digital revolution. Two terms are usually used here: digitization and digitalization. Unfortunately, there is no generally accepted definition of the two terms. In principle, one could say that digitization refers to the conversion of analog data into digital data, and the term digitalization subsequently refers to the use and procession of this digital data, which sometimes leads to a sometimes-fundamental change in work and business models [1]. The digital revolution does not stop at any area of life and also plays a major role in healthcare. Bertalan Mesko (and his team known as "The Medical Futurist"), who has published a large number of articles on current (technical) developments in the field of healthcare, sums up the upcoming challenges in the article: "Digital Health is a cultural transformation of traditional healthcare" [2] and defines "digital health" as:

> *The cultural transformation of how disruptive technologies that provide digital and objective data accessible to both*

> *caregivers and patients leads to an equal level doctor-patient relationship with shared decision-making and the democratization of care* [2].

Thus, innovative digital technologies may fundamentally change the current state of affairs in one area of society within a very short period of time. As in other industries, technologies such as virtual and augmented reality, artificial intelligence (machine learning, deep learning, reinforcement learning), big data, robotics, blockchain and telemedicine are considered innovative in healthcare.

Much evidence demonstrates that there is a link between innovation in laboratory medicine and quality of services provided, suitability of care pathways and possibility of implementing prevention strategies [3]. The young professional and researcher in laboratory medicine, or *Young Scientist*, has a key role in this process, and tries to seize new opportunities given by technological evolutions, such as the creation of a "smart" laboratory, that takes advantage of artificial intelligence not only to automate processes, but also to integrate information and manage flows, or by the use of the "omics" sciences, which represent a promising tool in the transition from research to precision medicine [4].

This article focuses on current and future technical developments in healthcare and addresses the skills healthcare professionals need to understand these technologies and use them in the best interests of patients. In order to use the new technologies profitably, one thing is needed above all: knowledge and training.

What knowledge and which skills are needed?

Yasmin Mei-Yee Weiß, Professor of Business Administration at the Technical University of Applied Science in Nuremberg, Germany, highlights the following skills as critical for the future [5]:

At first, a comprehensive technological understanding with:

- technology-related technical and methodological competence,
- IT security competence,
- knowledge in big data analysis and artificial intelligence and
- mastering of programming languages.

Secondly, an overarching methodological and social competence to:

- communicate effectively and efficiently,
- cooperate in an interdisciplinary manner,
- coordinate and delegate tasks and
- think in big picture terms.

Interestingly, even the so-called "digital natives", who grew up with digital media at the level of everyday consumption, rarely have job-related digital handling skills [6]. Many of these skills are important for the future of laboratory medicine. It is therefore surprising that overarching technological competence or content such as artificial intelligence or IT security is rarely taught in the regular training of physicians and scientists. The required skills can be divided into skills that are already needed and skills that will be needed in the near future. Skills that are currently required can be described as a general digital literacy: secure handling of digital communication (e-mail, online meetings, webinars), basics in IT security (phishing, spam, CEO fraud, etc.), basic programming skills and algorithmic thinking as well as basics of new forms of work (cooperative working spaces, agile, remote/mobile working). Due to the advancing technological developments, further skills arise that should expand the basic digital skillset in the future: a general data literacy that includes some big data competence and a basic understanding of artificial intelligence algorithms. Furthermore, the secure handling of cloud technologies (workspaces, machine learning tools, etc.) will play an increasingly important role. While it is not necessary for every laboratory specialist to be able to program a machine learning model or a robot, it is important to develop a basic understanding of the underlying technologies [7]. Any professional user of these technologies should be able to evaluate the predictions of such models.

Our purpose

Even though most physicians and professionals in laboratory medicine have received basic training in statistics, experience shows that a general understanding of modern data analysis is not yet available on a broad scale. As an example, the EFLM syllabus for postgraduate education and training for specialists in laboratory medicine [8] includes a variety of statistical applications - which are sometimes also counted among the machine learning algorithms – (exploratory data analysis, principal component analysis (PCA), clustering methods or robust linear regression for method comparison) but assumes that the necessary knowledge such as basic data literacy is already present. The problem of these missing skills has already been recognized by various players in the healthcare

sector. The UK National Health Service has been looking specifically at how to increase the confidence of healthcare workers in artificial intelligence applications and what skills are needed at different levels of competency [9]. The Stanford Medicine 2020 Health Trends Report [10] states that nearly three-quarters of all medical students and nearly half of all physician's plan to earn skills in data-centered disciplines such as advanced statistics and data science.

Therefore, we would like to focus on three key points, which should be communicated to professionals in laboratory medicine, and which should be implemented in future educational training:

- Data literacy (understanding and interpreting organized data)
- Data-driven decision making (drawing clinical conclusions from gathered data)
- Computational logic (being able to effectively communicate with computer scientists)

Survey on the digital competence among young scientists in laboratory medicine

To evaluate the state of digital competence among young scientists (YS) in laboratory medicine, we launched a worldwide online survey. The target population of this survey were YS working in the field of laboratory medicine with an age below 40 years. The aim of this study was to (1) assess the level of digital competence in YS, (2) identify the digital competence needs of YS in laboratory medicine, and (3) identify their expectations and desires for improving their digital competence.

Methods

A global online survey was conducted from 25/05/2022 to 26/06/2022 by Marie Lenski, a YS member of the SFBC and Jakob Adler, a YS member of the DGKL. The survey was disseminated to YS who are listed in three large networks: YS of the DGKL, the EFLM TG-YS, and IFCC TF-YS and its corresponding members, covering a base of 53 countries. The following items were addressed:

(1) Country of the participant
(2) Current activities in laboratory medicine
(3) Give 3 to 5 words that define/are related to digital competence for you.
(4) Did you have any education about digital competence during your academic qualification?
(5) If yes, please specify.
(6) If no, do you think that it would have been necessary?
(7) Are there colleagues in your institution who have a pronounced digital competence?
(8) If yes: are they available to participate in your projects or work with you?
(9) Fields of interest related to digital competence
(10) Do you use some of the skill mentioned above in your daily activity in laboratory medicine?
(11) If yes, please specify.
(12) How do you prefer to get the information?
(13) Additional comments about digital competence that could help us to better understand your needs and expectations about digital competence.

Data analysis was performed on Tableau and Excel.

Results

Response rate and participant demographics

A total of 119 YS participated in that survey, representing 40 countries. The countries of the participating YS are shown in Figure 1.

Most respondents were from Europe (60 responses), Asia (30 responses), and Africa (20 responses), while 5 and 4 responses were from South America and North America, respectively. 59 % of the YS indicated more than one field of activity, while 41 % indicated only one field. The breakdown of activities was: 81 % clinical chemistry (responses included: Clinical lipidomics, endocrinology, glycobiology, immunoassay analysis, LC-MS/MS method development, neurochemistry, newborn screening, toxicology, urinalysis, clinical analysis, clinical chemistry), 34 % hematology, 30 % immunology, 28 % genetics, 21 % microbiology, 11 % pathology, 11 % other activities (molecular biology, management, oncology, biobank).

Digital competence: where are we?

YS defined digital literacy mainly by the following terms: programming, artificial intelligence, machine learning, statistics, communication, Big Data and data analysis. In the area of digital skills, 80 % of the participants had no training during their academic education. Of those, 96 % thought it is necessary, 2 % thought it could be appreciated, and 2 % thought it is not necessary. Twenty percent of the participants had training in digital skills during their academic training. The description of these academic qualifications allowed to rate them as advanced for 52 % of them, which corresponds to a total of only 12 % of the YS who answered the form.

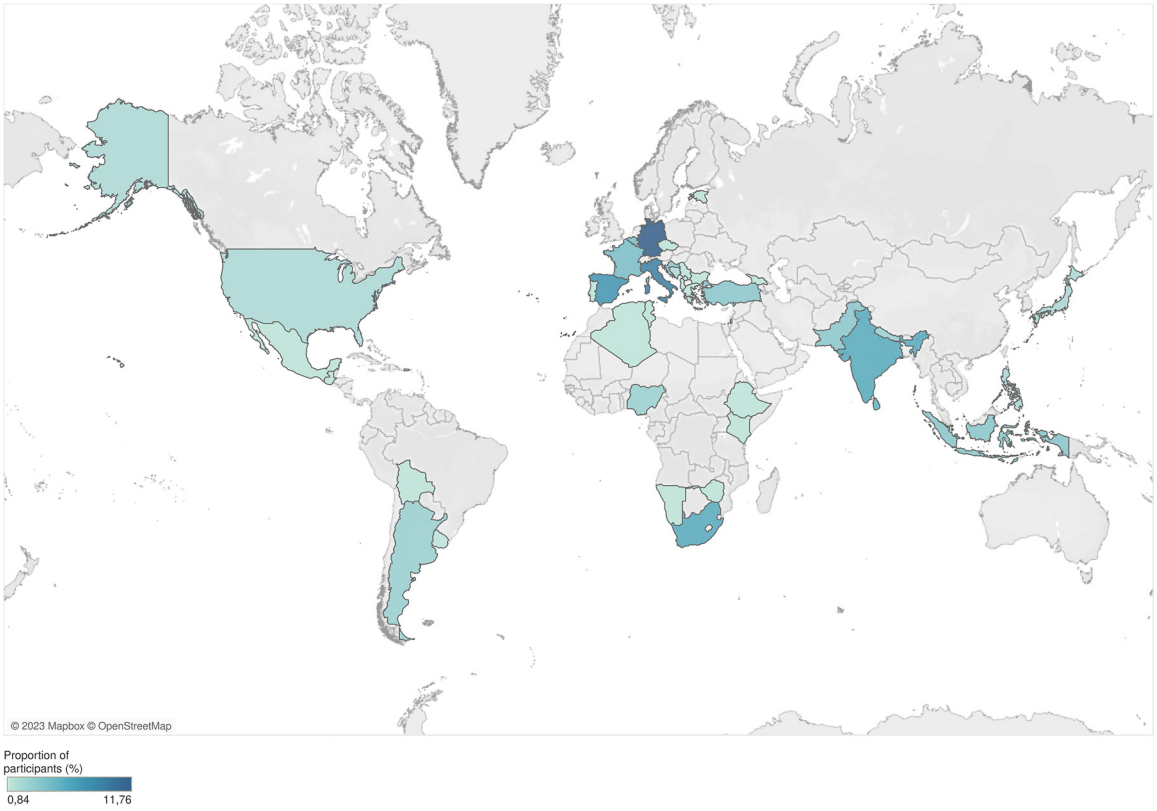

Figure 1: Countries of the participating young scientists. The depth of the blue color represents the proportion of participating YS to the total number of participating YS.

Needs of young scientists in laboratory medicine

YS identified different areas of interest related to digital skills detailed in Table 1, and foremost want access to concrete applications of digital skills in their daily work in laboratory medicine (79 % of participants). Seventy YS (59 %) declared using digital skills in their daily activities. Among them, 62 YS detailed the digital skills they used as shown in Table 1. One-third of participants (41 YS) have colleagues at their institution who have strong digital skills. Of these, 80 % estimate that they could ask for help with their projects or work. One-third do not have a digital literacy specialist in their professional environment, and one-third do not know.

Table 1: Areas of interest related to digital skills (n=119) as well as their application in laboratory medicine among daily users (n=62), according to participants declarations.

Digital skills	Proportion of YS who declared interest, % (n=119)	Proportion using digital skills in their daily activity, % (n=62)
Concrete applications in laboratory medicine	78	37
Big data analysis	67	16
Statistical learning (machine learning and deep learning)	65	15
Collaborative work	59	13
R progamming	55	23
Digital communication	51	31
Python programming	31	6
Business analytics and business intelligence	24	13
Others	1	10

Expectations of YS in laboratory medicine

The podium of preferred means of communication/information is captured by remote media, including 1) webinars (82 %) 2) online meetings (74 %) 3) video streaming platforms (e. g. youtube.com) (54 %). In-person symposia are also desired by YS (52 %), while other means of communication were mentioned by fewer participants (podcasts, newsletters, scientific journals).

Discussion and conclusions

The results of our survey clearly show that more knowledge and training in the area of digital skills is necessary and also wanted by YS. Based on the results of the survey, YS are aware of the importance of these modern tools and agree in the need of more learning resources. The survey also shows that the knowledge that is already available varies greatly. It is therefore a great challenge to offer resources that can do justice to every level of knowledge. It is important to provide introductory content, such as first experiences with a simple programming language or basics of IT security together with more advanced content, such as data analysis or the programming and training of machine learning models. It should be noted that professional societies such as the IFCC or the EFLM already offer courses in biostatistics or have founded their own working groups, e. g. on the topic of artificial intelligence. Therefore, existing resources should be incorporated into a general curriculum that teaches basic skills with digital technologies, basic data literacy, a basic understanding of artificial intelligence algorithms and social skills necessary in the context of collaborative and decentralized, asynchronous work.

How can we teach the skills of the future?

As we have seen due to the increasing demands and the lack of training, the question arises as to how this "digital skills gap" can be bridged. In Germany, we have therefore founded a "Digital Competence" working group within the young scientists of the DGKL.

German national working group on digital competence

The working group "Digital Competence" was founded in April 2021. Its aim is to teach basic technological skills in order to prepare future laboratory physicians and clinical chemists for the age of digitization and digitalization. This includes, teaching "computational thinking", i.e. understanding how computers work, what algorithms are and what they can do. To this end, we have started training in the Markdown language, a very easy-to-learn markup language for formatting texts [11]. In order to develop basic programming skills and to be able to analyze data from the laboratories, we trained principles of R programming [12]. Besides these basics, R packages like ggplot2 (data visualization) and dplyr (data wrangling) were covered on an advanced level. In order to enable more extensive projects in a version-controlled and decentralized manner, the working group members were familiarized with version management using git and the remote hosting of git files on GitHub [13]. This is exemplified by the development of shiny apps (as concrete applications in laboratory medicine such as method comparison or reference interval verification). In addition, a comprehensive collection of links on various topics of artificial intelligence, machine learning and deep learning was expanded on GitHub. To demystify IT buzzwords, so-called "IT buzzword bingos" are held regularly. These are 5 to 8-min presentations of an IT buzzword with the focus on explaining the technology as simply as possible and classifying it in terms of application examples. Topics covered here include tokens, blockchain, perceptron, Big Data in general, agile development (Scrum and Kanban), Six Sigma metric and others. Furthermore, topics such as IT security (most important threats, hashing, encryption and decryption, digital signatures) were dealt with and external speakers were invited for specific statistical topics (method comparison, time series analysis). The working group meets regularly online every 4 weeks.

International resources for digital competence in laboratory medicine

After the meeting of YS at EuroMedLab congress in the April of 2022 in Munich, we developed the idea to create common international resources to strengthen digital competence in laboratory medicine. Thereupon, the survey discussed above was initiated and a first online meeting of interested young scientists was held on 7th of November 2022. In this meeting further steps for the establishment of common resources were discussed. The possibilities mentioned are currently being evaluated and a roadmap for a digital competence curriculum is being developed. This curriculum should be as open as possible and bring together different sources. A varied learning environment consisting of tutorial articles, videos, exercises, technical articles, collection of helpful links, online meetings and in person bootcamps is crucial to meet the challenges of an international project with different languages, health systems and time zones. Moreover, in the environments with the lack of digital competence experts, a network of experienced online mentors and coaches can speed up the implementation of digital competences in laboratory practice.

Benefits of a broad spectrum of digital competence

If we manage to build up a broad knowledge base with regard to digital skills, this will result in many application examples for daily work in the laboratory. Such concrete applications can be the continuously developed autoverification of reports, the implementation of decision support systems or the prediction of diseases or response rates to patient-specific therapies. In addition, laboratories are facing increasing competition from large tech players such as Google, Amazon, and Apple, all of which are investing heavily in healthcare applications. Amazon, for example, has launched its own cloud-based analysis of omics data (Amazon Omics [14]). Especially the field of genomics, epigenomics, metabolomics, microbiomics, proteomics, etc. with its huge amounts of data requires the competence to analyze and interpret these data as well as to understand and further develop the algorithms for data evaluation. We are therefore well advised to strengthen the digital expertise in our laboratories.

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