Core Competences - A Mixed Methods Study of Biomedical Laboratory Scientists in Norway

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Background: This study describes how a sample of Norwegian biomedical laboratory scientists perceive their profession's core competences.
Method: An explorative sequential mixed method was conducted based on two rounds of data collection and includes qualitative and quantitative data. In a pilot study, seven biomedical laboratory scientists, from a middle-sized and a smaller hospital, contributed in a qualitative research interview. The interviews were transcribed and analyzed. In a main study, a questionnaire containing 36 statements was developed to investigate the biomedical laboratory scientists' perceptions of their core competences. The questionnaire was forwarded to a random selection of 2000 biomedical laboratory scientists. A total of 587 respondents completed the questionnaire, giving a response rate of 29.3 per cent.
Results and conclusion: The results of the interviews showed that biomedical laboratory scientists perceived their core competences as basically related to analyses and the quality of biomedical laboratory work. The data analysis of the responses from the survey revealed seven factors describing core competences in biomedical laboratory processes. The factors include pre-analytic, analytic and post-analytic competence, in addition to co-mentoring skills and collaborative competence.

Introduction

Background

In this article, we explore how biomedical laboratory scientists (BMLS) perceive their professional core competences. It is suggested that a better understanding of this may foster new knowledge about the development of the profession. However, the concept of competence is multifaceted, as for example, described in The World Health Organization (WHO) definition:

The ability to carry out a certain professional function, which is made up of a repertoire of professional practices. Competence requires knowledge, appropriate attitudes and observable mechanical or intellectual skills, which together account for ability to deliver a specified professional service (1).

Professionals will, due to differences in educational programmes, have somewhat different and ideally complementary competences. Future professions will most likely have their boundaries less clearly defined than in the past (2). According to Abbott (3), the evolution of professions is a result of their interrelations; development in one profession involves development in other, similar professions. The boundaries that protect a profession's integrity are not static and in Abbot's book on 'The System of Professions' (3), the concept 'jurisdiction' is central. Professions fight for jurisdiction or control over their respective fields.

Abbott (3) emphasizes that movements within one profession can also provide movements in other professions. In the light of this it is natural to understand the development of biomedical laboratory scientists' competences in the context of the tension between the engineering profession and the health profession - especially considering how movement in these subjects has affected (and affects) the development of biomedical laboratory scientists. Changes within and between professions may also be caused by a different mechanism of substitution and/or replacement. For example, blood sampling is an area where nurses and other health workers in certain places take over some of the biomedical laboratory scientist's function. At the same time, biomedical laboratory scientist has responsibility for pre-analytical variables and perhaps a more important role as a supervisor. This may be to ensure appropriate analysis bookings and minimize redundant orders, which are described by the Danish BMLS union (4).

Competence and collaborative practice

Barr (5) distinguish between three kinds of competence; common, complementary and collaborative competence. Common competence is competence held in common between all professions, while complementary competence distinguishes one profession and complements those which distinguish other professions. Collaborative competence is a dimension of competence which every profession needs in order to collaborate within its own ranks, with other professions, with non-professionals, within organisations, between organisations, and with patients and their careers. WHO (6) defines collaborative practice as a situation in which multiple health workers from different professional backgrounds work together with patients, carers and communities to deliver the highest quality of health and can therefore be considered as interprofessional competence.

It is reasonable to believe that professionals' abilities to work with others are probably linked to their perception of their own professional competence and what characterizes their role in health care. Clark (7) underlines however, that this is often overlooked in educational programmes. To be able to work across professional boundaries, it is important to have as clear an understanding as possible of the content of biomedical laboratory science. Furthermore, respect for other professions' competences and qualifications are essential to improve the collaboration process (8). Co-mentoring activities across professions are also regarded as important aspects in obtaining successful collaborative or interprofessional competence (IPC) (9); (10). Teams that have IPC may be an useful arena for discussing difficult cases, co-mentoring activities, and for professionals to support each other (11). On the other hand, professional rivalry is a possible challenge in interprofessional teams (12). Reorganization processes and implementation of interprofessional teams may blur traditional boundaries of jurisdiction and power relations between professions.

Biomedical laboratory scientists' core competence

Core, or complementary, competence is reflected in the concept of jurisdiction, which refers to a profession's control over knowledge and its application in an area of work. According to Cheetham and Chivers (2) core competence includes 1) knowledge/cognitive skills, 2) functional competence, 3) personal/behavioral skills, and 4) values/ethical competence. This conforms to the International Federation of Biomedical Laboratory Science (IFBLS) (13) guidelines, where core competence is defined as:

knowledge, skill, or ability that contributes to successful completion of a task on the job and is the ability to perform the activities within an occupation or function to the standard expected in employment.

IFBLS has focused on biomedical laboratory scientists' core competence since 2005/2006. At the 30th World Congress of Biomedical Laboratory Science in Berlin 2012, it was underlined that biomedical laboratory scientist is in the crossroads between the health professions and a deep understanding of technology for diagnostic purposes (13). The following quotation from the last world conference describes the core competences as:

The core competencies for Biomedical Laboratory Scientist/Biomedical Scientists include a thorough understanding of the fundamentals of biomedical processes and the processes of medical decision-making. This includes: development of methods, implementation of new methods, quality assurance of biomedical analysis, the analytical process from when an analyte is ordered, and the sample collection through to the validation and presentation of the result.

This includes issues such as knowledge of quality assurance, evaluation of pre-analytical variables and assessment and validation of medical laboratory analyses. IFBLS stresses that the biomedical laboratory scientist's core competence is based on scientific methods (evidence-based) and ethics of patient care. In addition, the biomedical laboratory scientist is an important link between health professionals and the public in the use of safe and appropriate diagnostic assays.

IFBL (1) outlines more specifically ten different competences which are at the core of the biomedical laboratory profession: 1) preparation and analysis of biological material, 2) correlation, validation and interpretation of results of investigation using clinical information, 3) reporting and issuing laboratory results, 4) maintenance of documentation, equipment and stock, 5) maintenance and promotion of safe working practices, 6) liaison with health workers and others to continuously improve the service, 7) participation in education and training of healthcare workers and others, 8) participation in research and development in research and developments activities, 9) demonstration of continuing professional development and 10) demonstration of professional accountability for biomedical laboratory science practice.

Research about core competences

A search was conducted of the databases PubMed, Medline and Science Direct (encompassing the years 2004 to March 2014). The following keywords were used in the search: biomedical laboratory science, biomedical laboratory scientist, clinical laboratory science, clinical laboratory scientist, bioengineering, biomedical engineering, competence, skills, knowledge and capability.

The results showed that, in broad terms biomedical laboratory scientists' competence is focused on 1) a general competence (laboratory methods, sample handling and instruments as well as being able to apply the rules and laws), 2) specific knowledge (chemistry and preclinical medicine) , and 3) attitudes and relational competence (14). Lumme (15) claims that core competence includes competence in laboratory processes, namely pre-analytical skills (collection and processing specimens), analytic skills (technical skills, perform analytical tests, preventive maintenance and troubleshooting) and post-analytical skills (assessment of results, clinical significance, decision making). Zinder (16) underlines that a BMLS should consult within the medical care team – advising clinicians on testing strategies and interpretation of the test results. Some BMLS will move closer to the patient because of point of care testing (POCT) and will be responsible for co-mentoring and accreditation of other health care professionals in the use of POCT (17). On the other hand, in Norway there is a tendency that the nurses and other health professions conduct blood sampling, while the BMLS are responsible for the quality of the pre-analysis and hence for co-mentoring on blood sampling.

Danish BMLS union (3) has performed a survey of BMLS` core competences and identity, based on a social anthropological approach. The result shows that the bio-analyses are central to the BMLS' field. This in- volves assuring the quality of all three parts of the bio-analysis: sampling, analysis and reporting. When it comes to the actual conduct of bio-analyses, the competences and participation must be embodied as the key to ensure standardized quality of patient care. Embodiment can be interpreted as the biomedical laboratory scientist performing in relation to different procedures, in the manner of routine work, which fol- lows the current manuals and standards. It should be noted that the profession is also characterized by a more participatory perspective, where BMLS interact and reflect on what is called the "right work". The survey also shows the basic values of the subject to be professionalism, accountability, quality awareness, and community feeling.

Objectives

The objectives of this study were to a) present biomedical laboratory scientists' perceptions of core competences based on two Norwegian samples, b) introduce a conceptual model of core competences in biomedical-laboratory science, c) discuss implications for biomedical laboratory science practice, with special emphasis on the different competences BMLS can have and d) introduce the development of a scale that can explore biomedical scientists' core competences further.

Methods

A mixed method design was used as a major re- search design and the approach applied in the study may be denoted as an Exploratory Sequential design. This means that a qualitative study was followed up by a quantitative study, often described as a QUAL – quan sequential design (21). One major dimension on which mixed method designs are differentiated is the time dimension. The time dimension is either sequential or concurrent. A sequential time order means that the qualitative and quantitative phases are conducted one after the other. A concurrent time order means that the quantitative and qualitative phases occur at approximately the same time—this is like running parallel mini-studies. A sequential design, as used in this article, is important when the results of one phase will be needed to inform the next phase and when the nature of the questions requires that a phase occurs after or before another phase (21, 22).

The design is used primarily and inductively in model development (cf. aim b), where the pilot study is used to identify central themes, which are used to develop and form test items in the questionnaire in the main study. Each of the two studies are distinct (sample, methods, design), but the overall theoretical thrust is exploratory and hence inductive in nature.

In the pilot study Almås and Ødegård (19) found, that BMLS' core competences are primarily related to doing analyses and the quality of biomedical laboratory work. In the main study, seven factors describing BMLS' core competence emerged (20). The factors include pre-analytic, analytic (two factors) and post-analytic competence (two factors), in addition to co-mentoring (a common competence) and collaborative competence.

Both studies have been published for Norwegian readers[1], but the studies have not been used as in the present paper. Instead, an overview that combines results from the two studies is presented with the purpose of gaining new insight into BMLS` perception of core competence. It is our notion that using the results from these two studies, in combination with a theoretical framework, will provide new opportunities to gain a broader understanding of the phenomenon of core competence among biomedical laboratory scientists (18).

[1]The editorial team of Biomedical Laboratory Scientist (Bioingeniøren) has given permission to publish the present article.

Study 1: Pilot

Sample: This sample consisted of seven biomedical laboratory scientists, each with at least five years of professional. experience. Two participants worked in a small hospital and five worked in a medium-sized hospital A total of four worked at the Department of Medical Biochemistry, one worked at the Department of Pathology, one worked at the Department of Microbiology and one worked at the Department of the Blood Bank. Six of the interviewees were women, which also approximately reflects the gender distribution among biomedical laboratory scientists in general (estimated the distribution is 91% female and 9 % male). The informants were not asked to provide any other background information beyond what is described here, to ensure the informants' anonymity.

Materials: A semi-structured interview guide (23) was developed and consisted of the following pre-formulated questions: What kind of skills do you think are important for practicing / working as a bio- medical laboratory scientist? What does it mean for you to be and to act/perform as a biomedical laboratory sci- entist? What are the norms and rules related to your profession? What do you think is most meaningful about your work as a biomedical laboratory scientist? What do you think distinguishes a biomedical laboratory scientist from other health workers? Can you describe a situation where you felt you were using your professional expertise as a biomedical laboratory scientist? In addition, there were a number of follow-up questions, depending on what the informants answered. The first author conducted the interviews, which lasted 30 minutes in average. Interviews were transcribed and consisted of a total of 18,134 words, with an average for each interview of about 2,590 (min = 659, max = 3,536).

Analysis: In this study, we used a combination of an inductive and a deductive analysis strategy. The questions used in the semi-structured interview were constructed on the basis of theory. The analysis was carried out in three steps. Step 1, the first part of the analysis, was to read through the transcribed interviews to form an impression of the key characteristics of the material. Step 2 was based on predefined categories based on Cheetham and Chivers' (2) conceptual model of professional core competence. Selected quotes were found and used to illustrate the major categories and the different sub-areas in the model. In Step 3, we examined the statements that did not come under any of the main categories (or subcategories). This section (Step 3) shows that the analysis had inductive elements, as new (sub-) categories were formed where statements did not fit the predefined categories.

Ethics: The Norwegian Social Science Data Services (NSD) advised that the interviews could be carried out. This approval was given because no registry was created for the project, the data were completely anonymous and the study did not concern any patients. The informants were contacted by telephone to request if they would participate in the study. None declined. Written and verbal information about the purpose of the project was provided. The informants were informed that the interviews were to be anonymized and deleted after the study was completed. Participants signed a letter of voluntary informed consent.

Study 2: Main

Sample: In Norway there are about 5,800 biomedical laboratory scientists, of whom 3,800 met the selection criteria for this study: a) having membership in Biomedical Laboratory Science Institute (BFI) and b) practicing as a biomedical laboratory scientist. BFI hired Synovate Market and Media Institute (MMI) who performed the data collection on-line. They randomly selected 2,000 potential respondents. A total of 587 responded, giving a response rate of 29.3 per cent. This is considered good for this kind of research and it is common for there to be a response rate of around 25 per cent in surveys conducted on so-called customer lists, as were used in this study. The survey was sent out, without incentives, to informants. The sample consisted of 91 % female and 9 % male, reflecting the gender composition of biomedical laboratory scientists. There were 73 (12%) biomedical laboratory scientists between 22 and 29 years of age, 170 (29%) between 30 and 39 years, 134 (23%) between 40 and 49 years and 210 (35 %) between 50 and 67 years.

Scale development: The design of the study was a non-experimental fixed design (24), as the phenomena under study were not manipulated or changed in any way. Furthermore, the design could also be described as a correlational design and a cross-sectional design, as all measures were taken over a short period of time. The questionnaire was called the Core Competence – Biomedical Laboratory Scientists Scale (CCBS). As there was no scale or questionnaire to be found regarding this theme, all items had to be developed, based on a) the pilot study, b) relevant literature about core competences and c) feedback from a reference group. The reference group was appointed by the BFI and consisted of three biomedical laboratory scientists from different educational institutions, one biomedical laboratory scientist from the practice field and the head of BFI. The reference group contributed advice during the development of the scale.

Some opinions that appeared in the qualitative study were modified to make statements in the questionnaire. For example, “*To understand the technical in the context of the medical, this combination, to understand when it is a technical error and when it is something wrong with the patient”,* was rewritten to say, “A BMLS is able to distinguish between technical instrument error and abnormal test results”. The statement, “*take care of the patients’ integrity”,* was reshaped to, “A BMLS treats the patient with respect”, and “phlebotomy *constitutes a major part of the profession”,* was rewritten as, “A BMLS has *phlebotomy* as an important part of his/hers responsibility”. The questionnaire was developed as relatively broad, in order to tap as many aspects of core competences as possible, substantiating the exploratory approach in the study. Each of the 36 items was rated by the participants on 7-point Likert scales, ranging from total disagreement (1) to full agreement (6). In addition an optional box indicating “Don’t know” was included (7). The questionnaire also contained demographic variables.

Data Analysis: As no prior research has been conducted to identify biomedical scientists’ perceptions of their core competence, there was a need for a psychometric investigation of the questionnaire. Exploratory factor analysis was used to obtain a first impression of the main constructs or dimensions underlying the phenomenon of core competence (25, 26). The data were analyzed using PASW 18. Furthermore, reliability analyses were used to investigate the questionnaire according to standards in scale development (26). The reliability of the factors was analyzed using Cronbach's alpha.

Ethics: Information that participation was voluntary, and that a decision not to answer would have no consequences, was included in a covering letter that accompanied the link to the survey. Consent was specifically given when the respondents answered the survey.

Findings

The pilot study results show that biomedical laboratory scientists perceived their core competences to relate primarily to skills and knowledge about laboratory analyses, hence the quality of biomedical laboratory work (cf. data analysis – Step 1). The participants used the concepts of *analyses* and *quality* repeatedly throughout all the interviews, i.e. analysis equipment, analysis of variance and quality system, quality improvement. To what extent and in what way there is a connection between analysis and quality was difficult to investigate in the qualitative study.

Next, looking for specific competences (data analysis - Step 2), the analysis showed that the most important competences for the biomedical laboratory scientists were: 1) knowledge/cognitive competence (*We have to have knowledge about the failure of different analysis result reports* and *To understand the technical in the context of the medical*…), 2) functional competence (Y*ou are conscious how the pre-analytical can interfere, that you understand when the test results are not right*..), 3) person/behavioral competence (*I am skilled taking blood samples, I feel confident that I will manage*), and 4) values/ethical competence (*Take care of the patients' integrity* and *Avoid blood sampling when someone is dying or avoid things that are not necessary*). The data also showed that some informants were concerned about collaboration with practitioners from different professions (cf. data analysis – Step 3). This was seen as a prerequisite for solving complex tasks. The following quote exemplifies this:

When it comes to interpreting the test results, it is best if biomedical laboratory scientist and the doctor collaborate... maybe because we often see aspects that they do not see, for example in hematology and out of the plots. It is important to have close contact – for example with the medical department – and the doctors. With regular meetings and contact, we can bring up aspects that we see. In this way, you also develop and learn a lot.

In the main study, the data were examined with respect to whether it was suitable for principal component factor analysis (PCA). Two criteria were used to assess this. Kaiser - Meyer - Olkin (KMO) is a measure of sample suitability and should be higher than 0.5. In our material, this value was 0.91. Bartlett's test was used to test the null hypothesis whether the variables were correlated or not. In our material, the null hypothesis was rejected ($p < 0.001$). Both criteria showed that the data were suitable for a factor analysis design. To determine how many factors should be extracted, we examined Eigenvalues where the criterion was that all factors with an Eigenvalue above 1.0 were extracted (11). Seven factors were extracted in our study. (A scree plot also showed that it was reasonable to extract 7 factors). The factors include pre-analytic, analytic and post-analytic competences, in addition to co-mentoring and collaborative or interprofessional competence.

Table 1 Rotated factor loading for 33 item. Principal Component Analysis.

	Factors						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Biomedical laboratory scientist:							
develops safe working practices	**0.67**	0.21	0.32	0.13	-0.13	0.56	0.19
works systematically	**0.69**	0.16	0.15	0.03	0.01	0.04	0.25
has knowledge on source of error for different analyses	**0.66**	0.11	0.11	0.20	0.11	0.06	0.04
follows procedures to ensure good quality	**0.62**	0.21	0.19	0.21	-0.06	-0.01	0.16
ensures that samples will be analyzed by suitable method	**0.62**	0.08	0.23	0.12	0.20	0.03	0.03
conducts control of laboratory equipment	**0.59**	0.17	0.09	0.24	-0.01	0.02	0.09
has tradition for reporting error	**0.54**	0.17	0.16	0.19	0.12	0.07	0.01
knows when exceptions from procedure can be justified	**0.56**	-0.03	0.14	0.14	0.20	0.15	0.07
make demands on correct specimen collection	0.18	**0.79**	0.05	0.17	0.17	0.03	0.13
has knowledge of how pre-analytical variables affect test results	0.21	**0.75**	0.03	0.17	0.17	0.08	0.08
is able to distinguish between technical instrument error and abnormal test results	0.22	**0.67**	0.02	0.12	0.23	-0.01	0.06
quality ensures the process from sampling collection to test reports	0.16	**0.64**	0.12	0.15	0.19	0.10	0.04
has phlebotomy as an important part of his/hers responsibility	0.04	**0.61**	0.20	0.06	0.08	0.15	-0.06
attends to the patient in specimen collection	0.24	0.18	**0.75**	0.09	0.05	-0.02	0.07
threats the patient with respect	0.71	0.18	**0.71**	0.09	0.10	-0.06	0.13
knows when assistance in phlebotomy is needed	0.32	0.15	**0.51**	0.00	0.04	0.09	0.06
communicates with both the physician and other health professionals	-0.02	-0.04	**0.52**	0.41	0.15	0.20	0.06
interacts with other health professionals	0.25	0.11	**0.63**	0.09	0.13	0.19	0.19
assures that quality control procedures are followed	0.34	0.08	-0.10	**0.58**	-0.04	-0.01	0.04
conducts necessary maintenance of laboratory equipment	0.03	0.10	0.06	**0.55**	0.12	-0.11	0.09
is responsible for reliable analysis results	0.09	0.11	-0.04	**0.53**	-0.02	0.12	0.16
understands the variation of test results	0.21	0.13	0.18	**0.53**	0.03	0.07	0.14
understands the importance of adequate processing of exceptions	0.15	0.18	0.17	**0.58**	0.06	- 0.03	- 0.02
has knowledge of method validation	0.25	0.09	0.20	**0.55**	0.12	0.11	-0.08
understands the clinical relevance of the analyses	0.13	0.46	0.14	0.13	**0.62**	0.02	0.12

	Factors						
	1	2	3	4	5	6	7
assesses the test results medical probability	0.04	0.30	0.08	0.07	**0.68**	0.12	0.03
has knowledge on how disease affects test results	0.16	0.31	0.08	0.08	**0.74**	0.15	0.07
has an important role in supervising patient regarding specimen collection and analytical work	0.10	0.18	0.11	-0.02	0.26	**0.74**	**-0.02**
has an important role in supervising health workers regarding specimen collection and analytical work	-0.02	0.56	0.11	0.05	-0.07	**0.52**	0.13
has an important role in co-mentoring patients in matters related to bedside analysis	0.11	0.08	0.05	0.07	0.20	**0.80**	0.01
has an important role in co-mentoring health professionals in matters related to bed-side analysis	0.11	0.53	0.10	0.10	-0.13	**0.54**	0.17
provides an important foundation for the diagnosis	0.20	0.08	0.12	0.14	0.05	0.02	**0.82**
provides an important foundation for patient treatment	0.17	0.15	0.15	0.09	0.04	0.01	**0.81**
% variance (total/cumulative variance 54.61%)	26.92	7.78	4.99	4.33	3.77	3.51	3.32
Eigen value	9.69	2.80	1.80	1.56	1.36	1.13	1.20

The factors are: 1 functional and analytical procedure competence, 1 – functional, quality conscious pre- and post-analytical competence, 3 – personal competence/ behavourial competence, collaborative and ethical competence, 4 – cognitive, analytical competence related to quality assurance and validating, 5 – cognitive, post-analytical competence, 6- personal, behavioural- and supervisor competence and 7 – functional competence within medical laboratory technology.

Seven factors account for more than 55 percent of the total variance. PCA with VariMAX rotation was used to find underlying factors that may shed light on the biomedical laboratory scientists' core competences where the correlations between the factors appear. Reliability analysis of the factors provided evidence of internal consistency, with Cronbach's alpha of 0.67 to 0.83.

The data analyses revealed a total of seven factors describing biomedical laboratory scientists' core competences. Process competence is a central aspect in the biomedical laboratory science. This includes analytic skills that include both procedural skills and assessment skills. Biomedical laboratory process expertise was also characterized by quality-conscious pre- and post-analytical skills.

Factor 1 is characterized by functional and analytical procedure expertise and the factor can also be seen in relation to technical skills (as part of analytical skills). Examples of this type of competence are: A BMLS *follows procedures to ensure good quality*. Factor 2 is about cognitive, functional, quality-conscious and pre- and post-analytical skills. This factor includes the idea that a BMLS has *knowledge of how pre analytical variables affect test results*. Factor 3 is characterized by personal / behavioral skills, collaborative competence and ethical competence. This we found in the statements: A BMLS *interacts with other health professionals, communicate with both physician and other health professionals* and *knows when assistance in phlebotomy is needed*. Factor 4 represents cognitive, analytical skills related to quality assurance and validation. Examples of this type of competence are *has knowledge of method validation, understands the importance of adequate processing of exceptions,* and *understand variation of test results*. This factor expresses something about the BMLS's judgmental ability and is included in analytical competence. Factor 5 is about cognitive, analytical competence and contains statements like A BMLS *has knowledge of how disease affects test results* and *assesses the test results medical probability*. In the model this factor, together with factor 2, are described as post-analytical skills.

Factor 6 is constructed of statements concerning personal / behavioral and co-mentoring or common competence. Statements included in this factor are: A BMLS *has an important role in co-mentoring health professionals in matters related to bed-side analyses* and A BMLS *has an important role in co-mentoring patients in matters related to bedside analyses.* Factor 7 is aimed at the functional competence of BMLS, in which BMLS analysis *provides an important foundation for diagnosis* and *provides a foundation for patient treatment*. This factor is about the function BMLS have in health care and is described as diagnostic partner in the model.

Discussion

Perceptions of core competence

BMLS are located at the intersection of two imperatives: a) to ensure holistic access to patient care with the patient at the center of a collaborative practice, which means participating in all stages in patient flow together with other health professionals and the patient (collaborative competence), and b) to meet the health care requirements of standardization, certification, control, quantitative targets and economic management strategies to improve health care in collaboration with other health- and social-care professionals (core competence) (19).

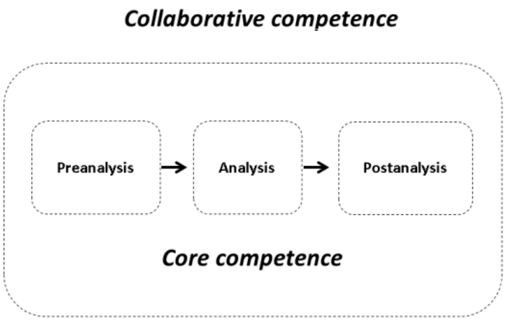

Fig.1 BMLS core and collaborative competence

Figure 1 is tentative and serves two main purposes. First, it provides a hypothesis about biomedical laboratory scientists' competence, based on empirical findings (Studies 1 and 2), theoretical input (2, 5) and a consensus decision about competence (World Congress of Biomedical Laboratory Science in Berlin 2012). Based on these sources, figure 1 represents relatively strong content validity.

As illustrated in Figure 1, biomedical laboratory process competence consists of pre-analysis, analysis and post-analysis and can be described as the core, or complementary, competence. This was evident in both the pilot- and in the main study. Pre-analysis describes cognitive and functional competence, while analytical competence comprises both procedural competence and assessment competence. Post-analysis involves cognitive and functional competence. Collaborative and ethical competence is connected to personal/behavioral competence. Functional and co-mentoring competence is a part of functional competence.

Analytical competence, presented by factor 1 and 4**,** strongly resembles what the Danish BMLS union (4) calls “reification” or procedural knowledge. Such routine-like tasks Danish BMLS union define as "work", where a biomedical laboratory scientist performs analyses without further reflection, but professionalism and experience is necessary to ensure that the work is carried out correctly. This is skills that imply that BMLS work systematically and develop work routines, also reflected in our findings. As illustrated in Figure 1 analytical competence also includes a participatory perspective, where BMLS interact and reflect when doing analysis. The BMLS controls laboratory equipment, according to Edgren (14) a general competence (sample handling and equipment). The statement that the BMLS ensures that samples are analyzed by appropriate methods coincides with one of the subsections (Analysis of specimens using appropriate /relevant techniques) in IFBLS competence description number 1 (Preparation and analysis of biological material). Lumme (15) asserts that the BMLS's core competence is to have knowledge about the errors of different analyses.

Pre-analytical skills, expressed in factor 2**,** may to some extent be compared with the first part of Paragraph 2 of IFBL’s description of core competences (Correlation, validation and interpretation of results of investigation using clinical information). This includes the concept that the BMLS has knowledge of how pre analytical variables can affect the analysis results, which corresponds to Edgren’s (14) definition of specific skills, such as pre-clinical competence. Lumme (15) describes pre-analytical expertise as collection and preparing specimens, which we see again in the statement of the BMLS that phlebotomy is an important part of their responsibility.

Collaborative competence, found in the pilot study and is connected to factor 3**,** has much in common with Section 6 of the IFBLS definition (liaison with health workers and others to continuously improve the service). Edgren (14) emphasizes that relational skills are part of the BMLS’s core competence. She also believes that attitudes are important. In other words, the ethical aspect is central, which we find in the statements, “protect the patient in the sampling situation” and “treat the patient with respect”. Ethical competence, as a part of factor 3**,** is also expressed in paragraph 10 of the IFBLS statement on points of expertise (Demonstration of professional accountability for BMLS practice).

Lumme (15) emphasizes that the assessment of results and clinical significance is included in the post-analytical skills. The skills described under Factor 4 may be linked to the second point in the IFBLS defini- tion (Correlation, validation and interpretation of results of investigation using clinical information). This is part of the analytic competence, which Lumme (15) defined as preventive maintenance and troubleshooting. In contrast to Factor 1, which is about "work", this factor seems to represent a responsibility / competence at a managerial level, and requires an expertise that implies more than procedural knowledge or reification. This, the Danish BMLS union (5) defines as "proper work", which is the accomplishment of tasks where the BMLS’s professionalism is seriously challenged. Factor 5 corresponds to the second part of Paragraph 2 of the IFBLS consensus (Correlation, validation and interpretation of results of investigation using clinical information). Factor 6 is extremely similar to Paragraph 7 of the IFBLS' consensus (Participation in education and training of health workers and others). It seem that the seven factors include both common (co-mentoring), collaborative (interprofessional) and complementary competences. Complementary competences include pre-analytical, analytical and post-analytical dimensions and describe the competence necessary for biomedical laboratory processes.

Implications for biomedical laboratory science practice

The theoretical perspectives, as well as the findings of the two studies presented in the present paper, show that the work of BMLS is multifaceted. This means that BMLS work in quite different contexts requiring different competences. In Figure 2, two dimensions were combined, to explore how different contexts will require different competences on the part of BMLS. Hence, this approach is different from the idea that BMLS as a profession has a single core. Rather, as illustrated in Figure 2, the competence of BMLS may consist of different combinations of core and common competence (cf. Barr (5)) dependent on the work context of the BMLS.

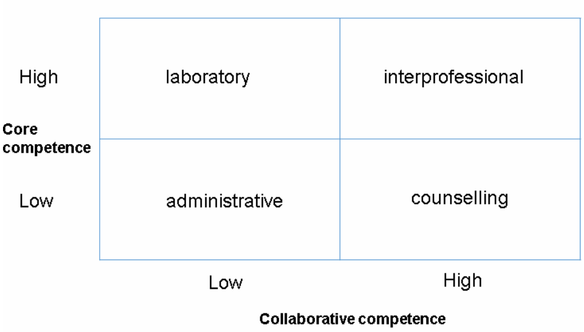

Fig.2 BMLS competences combined

Laboratory (high core/low collaboration): Some BMLS work in a laboratory without seeing the patient, like those BMLS working in Departments of Microbiology or Departments of Pathology. They seldom collaborate with other professionals and their role is clearly connected to biomedical laboratory process competence. Their focus is on cognitive and functional pre-analytical competence, analytical procedure competence and analytical assessment competence. This means they have strong focus on the core competence.

Administrative (low core/low collaboration): Most leaders of laboratories do not work at the laboratories and their focus is less on the core competence. BMLS in this position could be considered to be bureaucrats. They may be leaders, focusing on economic issues or organizational aspects.

Co-mentoring (low core/high collaboration): Some BMLS work at medical centers with limited analytical equipment. They interact with nurses, physicians and patients in collaborative practice and have more focus on collaborative or interprofessional competence. Sometimes their tasks are to supervise other professionals and patients in relation to how to POCT and therefore they have to have co-mentoring competence.

Collaborative or interprofessional (high core/high collaboration): In Europe there is a growing interest in seeing the BMLS as a diagnostic collaborative partner in patient flow. In Denmark and Norway, projects have been conducted where the BMLS is in the Clinical Department in a hospital to support when deciding which analysis to prescribe and how to interpret analysis results. In this way, in addition to having a focus on the core competences, they also need high degree of collaborative or interprofessional competence.

Beyond assuring the quality of the analysis process, BMLS may contribute to an interprofessional dialogue, including advising on testing strategies, interpretation of analysis results and supervision of blood sampling. As the results show, the future BMLS will need to acquire expertise in analysis and quality (connected to their profession-specific identity), but also a relational and counselling competence (linked to a welfare worker identity). Maybe the future BMLS will change from having a specialized role in health care to being a diagnostic collaborative partner in the patient flow, in close collaboration with other health care professionals.

Cheetham and Chivers (2) emphasize that in the future the professions will have their jurisdiction less clearly defined. As the boundaries are not static (3), the BMLSs' hegemony is in flux. If the role of BMLS is going to change to be a member of a diagnostic partnership, it is important to focus on collaborative competence to improve the future professionals' IPC in the BMLS study program. This means the BMLS will have to look beyond laboratory process competence as their core competence. On the other hand, if students are going to learn with, from and about each other (27) they will have to be conscious of their own role in health care. This is often overlooked in IPL (7). Related to practice, the model presented in figure 2, may be used as an analytical tool – for example in co-mentoring. A student looking for different places a BMLS can work, could gain new insight into the different competences required depending, for example, on the context where the BMLS is working.

Methodological issues

As introduced above, a conceptual model of core competence in biomedical laboratory science (Figure 2) may be an interesting and essential point of departure to explore different competence profiles. This may be highly rewarding as there are, to our knowledge, no instruments developed to capture BMLS' core competence. The development of new methodological approaches, for example a scale or questionnaire, will enrich our understanding of this field and prepare the ground for new studies. In the long run systematic reviews and meta-analyses of empirical studies will be possible.

Study 2, presented above, provides some interesting input to our understanding of core competences among biomedical laboratory scientists, as the factor analysis reveals several meaningful dimensions in BMLS competence. However, the development of a new and refined scale, based on prior findings (Study 1) and theoretical input will provide the potential for collecting information from much larger samples, and also across national borders. New studies will increase our understanding of the phenomena of core competences as new methods may be used to test the newly developed conceptual model presented in this study. Such future work might use confirmatory statistical approaches, for example. Therefore, based on the findings from this mixed method study (Studies 1 and 2), we suggest that a new measurement instrument should be developed. As the conceptual model contains a total of four different competences, each competence may be operationalized by 4 items, giving a total of 16 items in a new scale.

The weaknesses of the present study derive from the low response in Study 2. In Study 1 participants from a larger hospital should also have been included. It should also be possible to investigate biomedical laboratory competence across national boundaries, if a suitable test/questionnaire could be developed.

Conclusions

The mixed study design in the present study, combining a pilot study with a main study has given new insight into BMLS work. Norwegian biomedical laboratory scientists comprehend that their core complementary competence is connected with biomedical laboratory process competence, such as pre-analytical, analytical and post-analytical competence. In addition common competence, co-mentoring competence, and collaborative or interprofessional competence are important dimensions of biomedical laboratory scientists' competence, (cf. Figure 1) depending on the context in which they are working (Figure 2). Furthermore, the development of a new measurement instrument would give new and rich possibilities for exploration of BMLS competence.

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