How to connect? Peer networks and competence development in multiple thematic learning communities within one medical degree programme
Zhou, Yan

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1 General introduction
Healthcare is being challenged by the development of our society and patients’ needs. Technological innovation, epidemiological and demographic transitions, professional differentiation, and population demands are examples of these changing demands. These changes require also an instructional reform of medical education. The medical education reform in the recent century can be treated as three generations. At the beginning of the 20th century, the first generation was based on the scientific curriculum. In the middle of 20th century, medical education introduced small group learning, like problem-based learning (PBL). Recently, the third generation is competency-driven and considers local and global healthcare. Many countries and institutions have mixed patterns of these reforms and are going into the third generation. However, the effect of mixed patterns on students’ learning, especially competencies training, in a multicultural environment remains unclear so far.

Competency-based medical education (CBME)

A new educational approach, named competency-based medical education (CBME), is thought to be able to let the education community meet societal, patient, and learner needs of the 21st century, aiming to offer better and safer care. As Frank et al. mentioned, CBME facilitates reform of medical education because it focuses on both clinical and educational outcomes, provides mechanisms to promote a continuum of medical education, and a student-centered curriculum approach.

CBME is an outcome-driven educational format to train physicians. CBME can be based on different competency frameworks, which reflect the needs of patient, learners, and institutions. In this thesis, we focus on the CanMEDS 2015 physician competency framework. It is the most commonly used and integrated model to describe seven key competencies of health professionals in both North America and Europe. The current version presents seven competencies that future physicians need to acquire: Medical Expertise, Communication, Collaboration, Leadership, Health Advocacy, Scholarship and Professionalism. This framework consists of a critical integrating role (the medical expert) and six intrinsic roles (the petals of the flower as illustrated in Figure 1), corresponding to the complexity of the health care and health system on both the practical and personal level.
The purpose of using CBME is to ensure that future physicians are equipped with a sufficient level of basic competencies for their professional work needs by laying out the explicit developmental progression.\textsuperscript{15} Besides, another fundamental characteristic of CBME is that learning is personalized to each learners’ progress in some way. Therefore, CBME allows for a highly personalized learning process instead of a traditional, one-size-fits-all curriculum.\textsuperscript{16} However, due to the complexity of clinical practice, implementing CBME is challenging, and one needs to pay attention to context since it reflect the healthcare and educational system needs.\textsuperscript{3}

One of the advantages of CBME is that it can continuously incorporates new theories since CBME holds a series of principles, tools and approaches so that is able to transform, which differs from a fixed doctrine.\textsuperscript{3} Therefore, the implementation of CBME is always an iterative and dynamic process.\textsuperscript{3,17,18} It is known that different educational formats, such as Problem Based Learning (PBL) and Learning Communities (LCs) foster the learning of competencies\textsuperscript{19,20} PBL facilitates competency training through dealing with authentic problems in the clinical environment,\textsuperscript{21} and LC provides resources to

Figure 1. The CanMEDS framework 2015.\textsuperscript{7} Copyright © 2015 The Royal College of Physicians and Surgeons of Canada. https://www.royalcollege.ca/rcsite/canmeds/canmeds-framework-e. Reproduced with permission.
enhance interpersonal interactions and create supportive networks for competency training. Because of the flexibility of CBME, the (mixed) use of both educational formats within CBME may enhance competency training.

**Problem Based Learning (PBL)**

Problem-Based Learning (PBL) is a student-centered learning method. Students learn by understanding and dealing with authentic problems in small groups. PBL benefits independent learning, knowledge construction, teamwork, and problem-solving skills. The design and implementation of PBL are based on real-life problems, which form the trigger of the learning process. In medical education, real-life problems are mostly related to the patients or clinical environment. In this process, students need to first activate previous knowledge, find out their gaps in knowledge, fill these gaps with new knowledge and deal with problems by filling the gap between existing knowledge and expected learning outcomes. It benefits students’ new knowledge construction since they can relate it to what they already know.

PBL makes the learning process more attractive in a competency-based curriculum. Previous studies demonstrated that PBL is known to facilitate medical students’ general competencies and professional behaviour, as well as Communication, Collaboration, and Leadership competencies development. Besides, PBL also contributes to longer-term knowledge retention and knowledge application. Considering the advantages of PBL, combining CBME and PBL could facilitate students to activate their knowledge and train their professional competencies by dealing with patient problems. Another advantage of involving real-life problems in medical education is modelling an authentic professional situation for undergraduate students. Students are able to be familiar with how clinical workplace situations, patient consultation, clinical reasoning look like in their early study phase, and this helps to train competencies as realistic as possible.

**Learning community (LC)**

Creating learning communities (LCs) is a crucial way of group learning that is able to facilitate students’ interactions. Learning communities usually include active and collaborative learning activities. Loosely defined, LCs are groups of students who share
common academic goals and attitudes that meet regularly to collaborate on classwork, which benefits both their experience sharing, engagement, and professional competency development.\textsuperscript{15,33,34} LC could be treated as a supportive resource that benefits students’ engagement, academic performance, and interpersonal relationships. For instance, LCs can facilitate connections among students, faculty, and discipline, offer the chance to apply knowledge and experiences in collaborative teams, and help students to establish close longitudinal support networks.\textsuperscript{22,34} They have potent effects on students’ personal and professional identities, and social involvement also grows at the same time.\textsuperscript{35,36}

LCs can also be created within a curriculum about a particular discipline. A context-based LC aims to develop meaningful connections between students and their coursework.\textsuperscript{22} One way to do so is linking multiple courses based on certain themes, which can be called Thematic Learning Communities (TLC).\textsuperscript{37} Each TLC has its own theme, topic, content, learning process and faculty. With the change of health care in the twenty-first century, competent physicians usually work in a team rather than work alone, and they are unable to carry all necessary knowledge and skills in their head.\textsuperscript{38} Therefore, TLC helps medical training by using relevant content or discussing similar content under different relevant themes, which benefits students to acquire specific knowledge within that context. It also helps to enhance student comprehension, responses and adaptation by forming students’ social networks and providing emotional support.\textsuperscript{39}

**Peer relationships and social capital theory**

Peer relationships play a crucial role in the learning process, engagement, motivation and academic performance.\textsuperscript{40–43} Since group learning enhances interactions among students, both PBL and LC facilitate peer relationships among students and development of social capital.\textsuperscript{32} Social capital refers to people accessing and utilizing (borrowing or capturing) others’ resources (i.e., information, wealth) to attain their goals through social networks (based on their social relationships).\textsuperscript{44,45} Therefore, students’ social networks, to some extent, reflect their peer relationships and resources and through their peer networks, students can gain access to and mobilize the resources of others.\textsuperscript{45} So, students’ peer relationships, in line with the social capital theory, are a source of emotional and academic support that may enhance the feelings of safety, companionship, learning engagement, and achievement.\textsuperscript{33,40,46,47} For instance, supportive peer networks are known to enhance students’ academic performance.\textsuperscript{48,49} Students construct knowledge
by interacting with fellow students and creating meaningful connections between their experience and classwork. PBL and LC can provide an environment where students regularly meet, collaborate on classwork, and share experiences that can be beneficial for their academic development and interpersonal relationships.

Student’s peer relationships can be created in different ways. Apart from the formal relationships formed by curriculum administrations, informal relationships formed by students themselves also relate to their study. For instance, Indiana University School of Medicine (IUSM) had tried to improve informal interactions to support students’ professional, moral and humane values development. These informal relationships are not only affected by their formal relationships but also by their attributes. For instance, academic performances affect their peer relationships. Students with high academic performance tend to form large, more diverse social learning networks.

The literature describes two mechanisms to play a role in students’ informal relationships formation: Propinquity and homophily. Propinquity means that students prefer to connect with others when they are physically close with each other. It is usually caused by formal networks formed by faculty, such as LCs, which may lead to more informal interactions within LCs rather than outside LCs. Homophily means that students prefer to connect to each other based on similarities in their personal attributes (characteristics), such as academic performance, sex, nationality. For instance, domestic students are more likely to contact other domestic students. Likewise, students are also more willing to make friends or ask for advice from those who have a similar level of academic performance.

Globalization and internationalization

Considering the development of globalization, it is important that curricula focus not only on local health care problems but also take global health care into consideration. Nowadays, students increasingly show preference in learning and working in different context situations all over the world. Therefore, globalization and the internationalization of health care and health professionals should be integrated into education.

Besides, more students go abroad and study in foreign countries. The diversity
of students’ backgrounds seems to benefit students’ active thinking and intellectual engagement. However, many researchers found that international students have difficulties to be involved in the local environment and in establishing peer relationships with domestic students. Harrison and Peacock found that domestic students often showed ‘passive xenophobia’ towards international students. Likewise, Gareis and Schartner also found that many international students have limited friendships with domestic students. Since group learning facilitate students’ relationships, it may be wise to implement LC or PBL in a multicultural environment to enhance interactions and collaboration between domestic and international students.

**Rationale and Research questions**

As Eric et al. indicated, the reform of medical education is not a competition between theories, but a confluence of theories and methods to optimize medical education. The combination of CBME, PBL, and TLC may take their advantage and provide high-quality medical education. CBME is an outcome-based approach and emphasizes competency development, and as such provides clearly assessment criteria to relevant activities in the curriculum and to both PBL and TLC. The use of PBL let students focus on authentic problems in the clinical environment and the use of TLC fosters close connections between students and their coursework and offers supportive networks for learners. PBL and TLC provide an environment to share personal experience and offer timely, individual feedback, which facilitates performance-relevant information exchanging and professional identity formation as well. The combination also benefit students’ future career pathway by realizing their interests and merits at an earlier stage, avoiding mismatching between students’ preferences and public health needs. Thus, the combination of CBME, PBL, and TLC would be an innovative approach in medical education to finally train specialists with same level of core professional competencies. However, there is only limited literature about medical professional competency development in TLCs. Besides, no research has been done into the effect of the use of mixed educational formats on students’ learning and peer relationships in a multicultural environment.

Considering the internationalization of medical education, it is unclear what happens to the learning of competencies and knowledge in a multicultural environment when international students are distributed in group learning together with domestic
students. It is shown that TLC benefits students’ competencies training and knowledge construction by comparing academic performance between students with TLCs and students without TLCs, we do not know if students in international TLCs can acquire the same level of competencies and knowledge as students in domestic TLCs.

In addition, some previous studies investigated the effect of formal and informal peer relationships on learning and academic performance within higher education, but it is still not fully understood what the contribution is of such formal and informal peer relationships on students’ collaborative relationship formation at a later stage in medical bachelor study. Previous research mainly focused on first-year students who are in a transition phase from secondary education to higher education. Besides, little research has taken international medical undergraduate students into account. Since international students seem to have difficulties establishing informal relationships with domestic students, international students’ informal networks may differ from domestic students.

Furthermore, students’ social interactions may influence their peer relationships. The recent pandemic of COVID-19 and physical distancing restrictions, reflecting the challenge of healthcare, changed students’ social interactions and medical education to some extent. The interactions among students and faculty were fully virtually delivered through video conferencing software or social media platforms. On-site social interactions between students were maximally limited as well. Thus, students’ peer relationships drastically changed because of the COVID-19 pandemic. It is unclear to what extent students’ academic performances are influenced by the change as well. Besides, it is also necessary to consider students’ backgrounds when we explore the influence of the pandemic on students. International students, especially international freshmen, may have more difficulties when they have limited social activities.

Overall, this thesis attempts to answer the following main research question: How do thematic learning communities in a formal CBME and PBL based curriculum influence students’ learning outcomes and peer relationships? We specifically wanted to know: firstly, the influence of TLCs on students’ knowledge and competencies development. Secondly, we wanted to know the influence of TLCs and personal backgrounds on different types of informal peer relationships formation, especially the differences between first- and second-year students, and between domestic and international
students. And thirdly, the influence of COVID on peer relationships and academic performance.

**Research context**

In the Netherlands, undergraduate medical education consists of a three-year bachelor phase and a three-year master phase. This study focused on the bachelor phase. We introduced an innovative bachelor curriculum named G2020, which combines CBME with PBL and assign the students to four TLCs. The aim of this innovative curriculum is training future physicians who are capable of coping with the increasingly complex and constantly changing healthcare system and the rapid development of knowledge, technology and globalization. This dissertation focuses on the influence of this innovative curriculum on undergraduate medical students’ academic performances and peer relationships.

The four TLCs in G2020, Sustainable Care (SC), Intramural Care (IC), Global Health (GH), and Molecular Medicine (MM), all have their own theme, focuses, content, faculty and program design: TLC SC focuses on long-term care, and epidemiological and clinical (first-line) research. TLC IC deals with hospital and medical institutional care, and clinical and translational research. Both TLC SC and TLC IC are taught in Dutch containing almost entirely domestic students. TLC GH focuses on global healthcare issues, epidemiological and socioeconomic research. TLC MM deals with molecular and technological innovations, and translational and fundamental research. TLCs GH and TLC MM are taught in English containing both domestic and international students (Figure 2).

Students can choose one TLC when they enter the university according to their academic interests and language preferences, and stay in the same TLC for their three-year bachelor’s phase. G2020 curriculum contains a PBL-based basic program and a TLC-specific task program. The basic program is shared by four TLCs, which means that four TLCs learn the same content and have the same learning activities in the basic program. The TLC-specific task program differs between TLCs simultaneously and four TLCs have their own task designs. The task program trains students with specific knowledge, skill, and all seven competencies reflecting the TLC profile through different learning activities.
The shared program uses a PBL-cycle combined with tutor groups as educational approach. Every week the PBL cycle starts with a lecture and a live patient presentation. In G2020, patients join the patient lecture at the beginning of the PBL cycle and they have a live consultation with undergraduate students under the guidance of the lecturer (mostly a medical specialist). Students not only learn diseases from faculty, but also from a patients’ perspective. In this way, students need to apply their knowledge to deal with several patient-related problems. This patient lecture provides the starting point for further discussion in the small-scale (ten students) tutor groups. Each tutor group is led by one master student who is trained as a tutor. The tutor helps to guide group discussion, information sharing, and materials learning. Students in a tutor group meet twice a week to discuss patient-related problems by sharing their knowledge, experience and resources, and then fill the gap between current and desired knowledge and competencies.

In the last semester of the third year, students need to organize small scale (three to five students) groups by themselves to finish their bachelor thesis. They can select group members across all four TLCs. This is the first time they themselves can select group members in the formal curriculum. Students will spend one semester on finishing their bachelor thesis in small groups.

Overview of the chapters

This thesis aims to explore how students perform in a curriculum involving thematic
learning communities in a competency-based curriculum, while using problem-based learning and small group activities in TLCs at the same time. Although much is written about how group learning facilitates competency training, little research has focused on how parallel TLCs influence students’ learning outcomes and peer relationships in a multicultural learning environment. We compare students’ performances within and between TLCs regarding their learning outcomes, such as knowledge and competencies development, and the formation of their peer relationships. Furthermore, considering the internationalization in medical education, we compare students’ performance and interpersonal relationships between domestic and international students. In addition, we explore the influence of the COVID-19 pandemic on students’ peer relationships and academic performance. Since the chapters of this thesis are based on the curriculum G2020, and all articles are written to be read on their own, some repetition and overlap across the thesis is inevitable.

Chapters 2 and 3 focus on students’ learning outcomes in G2020. Chapter 2 explains the theoretical foundation of the curriculum design of G2020 and presents the overview of the curriculum design. We investigate whether students in different TLCs can acquire similar levels of learning outcomes by comparing students’ knowledge and competencies assessment results between four TLCs. The outcomes of students’ knowledge and competencies are shown and compared across the four learning communities. We noticed that it is difficult to compare students’ competencies performances in a diversified curriculum, as four TLC contain different TLC-specific task designs. Therefore, in chapter 3, we analyse students’ competencies performances in the basic program, which is shared by all TLCs. We explore the influence of mixing international and domestic students in some learning communities on students’ competencies training. Different from the TLC-specific task program, which trains and assesses students’ seven competencies, students share the basic program and are assessed on three competencies: collaboration, leadership, and professionalism in tutor groups. We compare the assessment results of those three competencies between international and domestic TLCs and between international and domestic students.

In chapter 4, 5, and 6 we explore how curriculum G2020 influences students’ peer relationships, considering students’ attributes. Chapter 4 explores how students choose their fellow students to form small teams to complete their bachelor thesis. We consider the influence of the formal curriculum (LCs and previous tutor group
collaboration experience), students’ backgrounds and their informal peer relationships. We found that although the formal curriculum relates to students’ decisions when selecting team members within or across LCs, the informal peer relationships formed outside of the formal curriculum is worth paying attention to, because almost 40% of the students choose to collaborate outside of their LCs.

Therefore, in the next study, we used an online survey study to investigate students’ informal peer relationships. In Chapter 5 we use social network analysis to present how students form their different types of informal peer relationships, considering students’ backgrounds. This chapter addresses the research question: What are the differences between the five informal peer networks (study-related support, collaboration, share-information, friendship, and learn-from networks) in terms of network structures? To what extent is the formation of students’ informal networks determined by their formal networks (LCs) and to what extent are background characteristics (gender, nationality, academic performance) linked to informal networks? We compare informal networks between first- and second-year students, and between international and domestic students.

The pandemic of COVID-19 has changed our daily life, as well as the way students learn. Undergraduate medical students in the Netherlands, including international students, had to learn online most of the time and we expected that this would influence the informal peer relationship. Hence, in chapter 6, we conducted an online survey study again asking students about their informal relationships during the COVID-19 pandemic and compared it with the previous study. We use mixed methods to analyse the influence of COVID-19 restriction measures on students’ informal peer relationships and academic performance, and what difficulties students met and what kind of help they need in future.
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