SOCRATES, PROBLEM-BASED LEARNING AND CRITICAL THINKING—A PHILOSOPHIC POINT OF VIEW

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Problem-based learning (PBL) is a learner-centered educational method based on the principles of heuristics and collaboration. It has been considered an effective learning method in general and in professional education, especially in medical education. This article analyzes the thinking structure and philosophical background of PBL through the educational ideas of Socrates and the truth conception of Karl Popper. In the different phases of the PBL process, various truth conceptions will help to formulate the thinking framework of PBL—from Socrates' truth of openness toward the truth of scientific accuracy of our modern age. Meanwhile, Popper's scientific theory of falsifiability further leads us to discuss the relationship between PBL and critical thinking.

Key Words: critical thinking, Popper, problem-based learning, Socrates, truth
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In comparison to traditional, passive, and individual learning methods, problem-based learning (PBL) is a learner-centered educational method based on the principles of heuristics and collaboration. It has been considered an effective learning method in general and in professional education, especially in medical education. In the context of medical education, PBL encourages medical students to integrate basic and clinical science and further foster their problem-solving skills in disease diagnosis [1]. Previous literature has focused on the educational theory and methodology of PBL in medicine. However, there has been little discussion from a philosophical or epistemological background [2]. This article analyzes the thinking structure of PBL through the educational philosophy of Socrates and the concept of Popper's Falsifiability (or refutability or testability).

First, this article will examine two of Socrates' views on educational philosophy, his concepts of wisdom and midwifery skills, to compare the prototype of the thinking structure of PBL [3–5]. These views will describe an education situation which encompasses a central question or mystery to think about. Under such a situation, thinkers approach a question in an amateur way and keep an open, curious attitude to the question. Moreover, tutors in this situation respect the diversities among individuals and help learners to develop their thinking skills.

Secondly, we will explore the different truth conceptions that may guide the process of PBL. The traditional definition of truth conception in natural science

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is to find out the facts. The purposes of professional education are to give people the ability to make timely judgments and to teach them particular skills (truth of correspondence). However, in general education and in PBL (two important components of holistic education), another way of amateur thinking, *openness*, is the main educational purpose. This involves not only the acquisition of professional knowledge, but also the attitude toward learning. In this part, the theory of falsifiability proposed by the philosopher Karl Popper provides a critical rationalism about the *truth of openness*, helping us to better explain the essence of holistic education. In addition, this theory can guide us to further explore the relationship between PBL and critical thinking [5–7].

THE PHILOSOPHICAL BACKGROUND OF PBL AND CRITICAL THINKING

What is PBL?

PBL is conducted in small group tutorials which consist of a tutor, chair, scribe, and several group members. Normally, the tutor does not hold the responsibility as a knowledge provider and will not lead the discussion directly. Instead, he/she will play an important role in creating a positive atmosphere and in facilitating the discussion. Thus, the focus of PBL is not on the tutor.

Regarding the role of learners, Greene [8] has categorized students into four major groups based on their performance in the process of PBL: (1) student as a tutorial group member; (2) student as a teacher; (3) student as a critical thinker; and (4) student as a learner. These multiple roles of students not only lead to interactive relationships among all participants, but also enable students to be objective and to think critically. Using a game as a metaphor, the player is the student while the referee is the tutor who maintains the rules during the operation. Obviously, what makes the game amazing and exciting is the vivid interaction of players. In the process of PBL, the most interesting part will be the inspiring questions raised by students and the sense of achievement from solving the mystery.

What is Socrates' "wisdom"?

Plato mentioned in his *Apology* [9] that there once was a friend of Socrates who went to Delphi and boldly asked the oracle to tell him whether there was anyone wiser than Socrates. The Pythian prophetess answered there was no man wiser. When Socrates heard the answer, he wondered: What can the god mean? And what is the interpretation of this riddle? As for himself, he has no wisdom, small or great. What can the god mean when he said Socrates is the wisest of men?

To refute what the god had said, Socrates went to those who had the reputation of wisdom. Through all of the discussions, Socrates found that none of them knew anything really beautiful and good; he was wiser than them. He found that the wise men knew nothing, but thought that they knew something, but he himself neither knew nor thought that he knew. In this sense, Socrates seems to have a slight advantage over them. In fact, the god meant to say that the wisdom of men is little or nothing. He is not speaking of Socrates in particular, he is only using his name as an illustration, as if he said those like Socrates, who know their wisdom is in truth worth nothing, are the wisest.

What is Socrates' "midwifery skill"?

Once Theaetetus mentioned to Socrates that he had made great efforts to answer questions posed by Socrates, but had no satisfactory answers to offer. Those questions often came to his mind, and caused a feeling of anxiety which Theaetetus could not shake off. Socrates said to him, "My dear friend, it is because we all had faith, and you yourself had the faith in you as well, that you had something within you which you are bringing to birth and these are the pangs of labor." Socrates told Theaetetus he was the son of a midwife and therefore practiced midwifery skills as well. But he was more concerned about looking after the soul while someone was in labor, and not after their body. He was able to distinguish whether the thought which the mind of the young man brings forth is a false idol or a noble and true birth. If it was a false idol, it was to be silently demolished. In fact, Socrates had actually known some people who were ready to bite him when he deprived them of a daring folly. They did not perceive that Socrates acted from good will [10].

What is Popper's "Falsifiability"?

Karl Popper belonged to the school of critical rationalism, which rejects the philosophical view of classical empiricism and the observationalist-inductivist account of science. The core of his idea comes from

falsifiability, and he argued that a theory should be considered scientific if and only if it is falsifiable [11]. Falsifiability briefly means that any scientific theory can only be proved to be a false one, but it cannot be shown to be true. For instance, Einstein's Theory of Relativity has proven that Newton's laws of dynamics are false or uncertain; therefore the traditional laws of dynamics are overthrown, yet the Theory of Relativity has still not been proven as a true theory. A scientific theory is considered as good not because it is true, but due to its ability and flexibility to accept various kinds of queries and challenges, while at the same time it is not proven to be a false theory. Popper's concept caused a great shock in science as a good scientific theory was no longer seen to be a kind of closed and self-authority-defending theory. On the contrary, it must stimulate various challenges and queries open-mindedly. It seems the more a theory can stand up to the test, the closer it is to the truth. By unlocking scientific authoritativeness and accepting challenges, the concept of falsifiability shows the spirit of scientific critical thinking and openness.

What is critical thinking?

The California Critical Thinking Disposition Inventory (CCTDI) offers us a comprehensive outline of the nature of critical thinking [12]. The CCTDI defined critical thinking as possessing seven characteristics: truth-seeking, open-mindedness, analyticity, systematicity, critical thinking self-confidence, inquisitiveness and cognitive maturity. Therefore, we can say that critical thinking is an attitude of truth-seeking (truth-seeking, cognitive maturity), a rational way of thinking (analyticity, systematicity, cognitive maturity), and a manner of open-mindedness (open-mindedness, critical thinking self-confidence, inquisitiveness).

Apparently, the so-called *critical spirit* is one which respects the authorities of truth within reason, but does not trust authorities blindly. It challenges the authorities, but does not regard one's own idea as the only authority. Therefore, critical thinking is not only logical and scientific reasoning, but also includes a kind of behavior corresponding to rationality, or so-called practical reasoning. In conclusion, meditating upon critical thinking helps to expand our understanding of the concept of rationality and helps one to cross over the divide between natural science and humanity at the same time. This point of view is especially important to the use of PBL methods in general

education, because the truth of general education is built out of the openness of practical reasoning. This is very different from professional education, which is built on the accurateness of logical reasoning. To recognize a variety of truth conceptions and their purposes is vital to our PBL teaching, because PBL is symbolized as a bridge connecting general education and professional education. We will proceed to analyze the relationship of these two kinds of education further.

Next, we adopt the methods of philosophical analysis and demonstration to clarify the relationship between PBL and critical thinking. We will use these models to explain the thinking structure applied in the course of PBL. The reasonableness of the demonstration is based on our rationality in thinking. If we could determine what actually happens in a PBL teaching course and then provide comments that guide future teaching, the analysis will be worth the effort.

FURTHER CONSIDERATION OF THE FRAMEWORK OF PBL AND CRITICAL THINKING

What can the "wisdom" of Socrates inspire in education?

It can inspire a better understanding about the non-professional model in PBL.

In the asking and answering of riddles, what is the only thing that cannot be said at the beginning? It's the answer, of course. The fun of the game lies in the absence of the answer, and this absence enables the players to imagine the answer freely.

Let's think about it, what are the differences in the performance of the veteran and the novice? Veterans might be very familiar with the rules and patterns of setting up the riddles, or, due to their previous experiences, they might be able to figure out possible answers immediately by applying analogy. Perhaps the rates of accuracy are high, but, by contrast, the game seems to be less interesting; because veterans respond habitually and mechanically, the game appears to be dull. This occurs because, while analyzing the questions, veterans tend to answer according to their previous experiences. They repeat the application of principles and compare this case with former cases, as well as thinking in a way that focuses solely on the answer.

When faced with a question, veterans search for the fact which closely corresponds with their own presumptions. In fact, knowing nothing at all is pretty much unacceptable for these veterans. Perhaps such a way of thinking is efficient, and probably does help to achieve high accuracy rates, but the shortcoming is the thinkers seem to have neglected other important and noticeable facts. Especially in dealing with certain cases regarding medical ethics, this shortcoming is obvious. A veteran's perception of a present ethical situation will be influenced by previous cases experienced, and will be prejudiced by first impressions. As a consequence, the noticeable ethical requirements of individuals may be neglected.

Socrates' wisdom is about understanding one's own knowing nothing at all and abandoning one's prejudice. When compared with veterans' experiences, we can symbolize a beginner's approach to a question as a nonprofessional model. According to Socrates' educational concept, the nonprofessional model is not a damaging and must-overcome condition, because in the process of PBL no one has special authority over the use of knowledge. Therefore, the students can take turns to play different roles as tutorial group member, teacher, critical thinker and learner, each of which provides different perspectives on the case. Thus, PBL, in its role as a nonprofessional model, is not purposed to develop professional knowledge. Instead it sustains the curiosity of students in the process of PBL while providing suitable stimulations. This execution will also provide the best opportunity for the learners to keep creativity [13] in such learning experiences.

What can the "midwifery" of Socrates inspire in education?
It can reinforce the uniqueness of each student.

While students keep pondering a matter, knowing nothing at all doesn't mean they are totally ignorant about the question or problem. In fact, a good teacher should exemplify Socrates, first by guiding the students to recognize their own ignorance, and then to keep their minds surrounded by these questions until they cannot stop thinking about them. Next, a teacher exemplifies Socrates' midwifery skills, which means helping to provide a good and spontaneous learning process similar to the process by which we learn from our own painful experiences [14]. True knowledge has

to be accumulated and suffered for a long period of time before it is formally delivered.

In comparison with the traditional lecture approach to teaching, there is a specific characteristic of PBL teaching. When taught through lectures, learners normally merely know the knowledge they are given, rather than understand it. Even if they have truly understood it, they rarely have faith in themselves (let us think about the meaning of *critical thinking self-confidence*). The main difference between lectures and PBL is governed by how deep the learners immerse themselves in the learning process. Besides having recognized his own knowing nothing at all and submerging himself in the pain and curiosity of the learning process, most importantly, Socrates realized that to be a successful midwife, he had to look after "the soul while delivering, but not the body". The analogy within PBL teaching suggests that, for a successful teacher, the responsibilities do not merely consist of the instillation of knowledge, but distinguish the different characteristics of each learner as well as their involvement in the learning process. This situation is similar to an experienced midwife, who is able to distinguish every detail and different conditions in the delivery process, and make a judgment on when is the best period for delivery. For example, perhaps there are some students who are full of anxiety, but with some opinions that are not expressed. Or there can be other students who appear to be helpless as they feel unable to involve themselves in the discussion. Some may possess the characteristics of being spontaneous and active, while some may not. Tutors have to be more aware of the uniqueness of each student and give suggestions accordingly.

As a result, a leader in PBL needs to have the same practical wisdom as Socrates. Tutors and learners need to have faith in and reliance on each other, recognize the qualities and shortcomings of each other, and treat each other as unique individuals. Therefore, PBL is different from traditional lectures and seminars, as traditionally, the main purpose of education is to gain knowledge and the uniqueness of different learners isn't that important. However, in PBL, learning is actually a kind of practice of life. Its goal is not merely to instill knowledge, but also includes enhancing the birth and creation of knowledge, cooperation among team members and the attitude of learning. These are the roles of students as tutorial group members as Greene [8] has suggested. The uniqueness of each

student determines the success or failure of a particular learning process, as each of them is not only in the PBL team, but they are the team itself. Thus, both the learners and teams are unique. The duties of the tutors or the assistants are to focus on the uniqueness of each PBL process and provide guidance accordingly. The above point of view will favor our following discussions on critical thinking.

What is the nature of truth in professional and general education?

The truth of correspondence is at the heart of professional education, while the truth of openness is necessary in general education.

Is PBL becoming a part of professional education? Or is there any other pattern in PBL that is different from professional education? To answer the above questions, we have to be clear on what kind of thinking structure is being used by the learners in the PBL process. And we must know what concepts of truth such thinking is based on.

First we need to explain that the truth which leads to professional education is the truth of correspondence. The truth of correspondence means that judgment and behavior correspond to the accuracy of fact. For instance, professional careers, especially in medical institutions, are basically targeted at the instillation of knowledge and skills as their educational purpose. If a trained and skillful medical student manages to learn and demonstrate the superior surgical skills which are necessary for a given form of surgery, professional education can be said to have occurred. The main goal in professional education is to match knowledge with fact, as well as skills with goals, perfectly.

Compared with the single direction of professional education, the guideline of general education is the truth of openness. General education does not target knowledge matching perfectly with facts, but focuses more on opening the horizon of views of the learners. Thus, the openness of general education has two different features: the openness of scope, and a transcendent openness. In comparing the two, the second type of openness is more vital. We can notice this kind of transcendent characteristic even within the most profound professional research. For example, Einstein was a scientist and talented violinist simultaneously. Within the scope of openness, music can be a source of inspiration for a physics theory.

Transcendence provides similar inspiration to scientists and musicians: while facing infinite areas of transcendence, humans as finite beings (finitude) experience the occurrences of infinity, and finally notice our own limitations. Hence, general education, which aims to achieve the ideal of the whole person is definitely not from an individual perception, but to notice the modesty of an individual from an infinite perspective. Therefore, even within those profound researches, this kind of transcendence is noticeable. In fact, an expert scientist is actually one who is modest in every field of study, including the truth. Thus, general education is neither an additional education, nor a pre-education of professional education, because the diversities of professional and general educations are based on different conceptions of their leading truth; that is, they distinguish between general and professional education based on their different characteristic of truth separately as mentioned above. Broadly speaking, PBL should contribute to the education of humanity by combining both types of education as a whole, because we can find the two different conceptions of truth existing simultaneously, but in different phases of PBL. This point is discussed more comprehensively in the following section.

What is the truth conception in PBL?

It is falsifiability as a clue for our thinking.

We have already discussed the difference between general and professional education with regard to their truth conception as guidance. It will favor our analysis of the special nature of PBL more clearly. As we know, general and professional types of education follow different directions: one moves toward the horizon of openness, and the other toward accurate facts. Now, a critical question emerges: what kind of role can PBL play between general and professional education?

The simple answer is that PBL possesses both kinds of truth, but emphasizes them differently in two phases. In first phase, PBL is directed by the truth of openness as in general education. That is, the learners will not care about the accurate facts, which are mostly the concern of professional education. PBL is one special learning style, which surrounds the central question and allows all learners to enter into the critical atmosphere to facilitate their own ideas. They should take off their prejudices and be aware they

know nothing at all, as we have described in the idea of Socrates' wisdom. Learners should enter the question at the beginning with a nonprofessional model, be attracted by the difficult puzzle, and enjoy imagining the possible solving of the mystery.

Because the learners are not be constrained by the demand for accurate facts, they can propose their assumptions more freely. The nonprofessional model will eliminate the asymmetry of knowledge, which is caused by the authority based on the presence of some specific knowledge owner. Thus, the thought among each learner could flow smoothly at the same level, to promote the enjoyment of study.

After identifying the questions, the learners will gradually be directed toward a solution. The second phase of PBL is the pursuit of fact. However, to get the answers within the PBL process is not easy, because it will involve a dialectic process. This is similar to the afore-mentioned truth conception in scientific theory or the explanation suggested by Popper. We present a hypothesis as an explanation of the facts, but the occurrences of other possibilities are inevitable through certain challenges. As we know, several steps, including an unprofessional process of pondering, fact searching, and hypothesis forming, are involved in the different phases of PBL, and match closely Popper's point of views. This avoids textbooks and authoritative answers given by tutors. Otherwise, due to the influence of authorities, even if different kinds of facts occur, the learners will habitually accept those facts which confirm previous theories and deny the possibilities of other facts which oppose them. As a result, such prejudice will discourage the open-mindedness of learners and reduce or block their creativity.

Having recognized the two-phase structure within the PBL process, it will favor a better understanding of the real-time requirements of the learning process, help teachers to respond accordingly to promote better or more challenging questions and lead to the production of knowledge. The main purpose of this article was to explain the idea of Socrates' wisdom as one approach to central questions, which will avoid any obstacles to our free-thinking. Socrates' midwifery skills can vary and deepen our questions and discussions in PBL, and finally, based on the concept of Popper's Falsifiability, learners can remain open-minded to all facts and evidence, whether they support or oppose our hypothesis. All of these

processes in PBL should lead the learners from the suffering of a puzzle to thinking according to the answer of the last question.

What is the relationship between PBL and critical thinking?

At last, we can discuss the relationship between PBL and critical thinking. PBL is a learning method based on the practicality of life. In other words, the uniqueness of each learner and his or her life experiences directs the outcome of PBL. On the other hand, critical thinking is not restricted to the rationality of logical and scientific thinking, but includes practicality or behavioral rationality as well. Critical thinking apparently involves an ethical attitude by respecting others' opinions and the habits of self-criticism and introspection. In conclusion, PBL and critical thinking are not merely restricted to the pursuit of knowledge, but in fact involve numerous ethical attitudes as well as the wisdom of practice.

Concretely speaking, according to the definition of CCTDI, critical thinking includes seven different characteristics: truth-seeking, open-mindedness, analyticity, systematicity, critical thinking self-confidence, inquisitiveness and cognitive maturity. Through systematic analysis between critical thinking and PBL, we can conclude:

- In different phases of PBL, we emphasize the different characteristics of critical thinking separately. Thus, open-mindedness and inquisitiveness are included in the first phase while analyticity and systematicity are emphasized in the second phase. Truth-seeking is a characteristic possessed by both phases.
- Critical thinking and self-confidence are related to the self-learning process within PBL. The only way to develop self-confidence in our own ideas is to practice. This characteristic is under the application of Socrates' midwifery skills.
- Lastly, the participants of PBL ought to maintain their open-mindedness to accept different challenges to their ideas. The related critical characteristics are critical thinking self-confidence, inquisitiveness and cognitive maturity. These all are underpinned by the concept of Popper's Falsifiability.

In the end, we can sum up critical thinking as an attitude of respecting the truth (truth-seeking, cognitive maturity), thinking rationally (analyticity,

systematicity, cognitive maturity) and having an attitude of openness (open-mindedness, critical thinking, self-confidence, inquisitiveness). As indicated above, we draw a comparison between the seven main characteristics and several thinking structures based on various kinds of truth; hopefully this can provide some helpful references to tutors and assistants.

CONCLUSION

In this article, we have introduced Socrates' wisdom, Socrates' midwifery skills and Popper's Falsifiability, and have used them to analyze the two-phase structure in the course of PBL. We have also introduced the different truth conceptions that are emphasized in different phases of PBL. In fact, Socrates' educational method is a good example and solution for training critical thinking. According to our analysis, the following are several suggestions for the optimum use of PBL:

1. One of the keys is to lead with a good question. A good question ought to be impressive, and capable of posing sufficient possibilities or conflicts (for example, PBL on medical ethics). Besides, a good question is supposed to have a relation to our daily lives and should avoid applying too much professional knowledge in advance [15]. (Socrates' wisdom)

2. In the process, tutors or assistants need to guarantee the unremitting progression of the question proposed. Even if the questions are being led to certain fields with which the tutors or assistants are unfamiliar, the discussions should still be carried on. This is because, in the PBL process, a leader is a learner as well. Therefore, neither tutors nor students should flinch or feel embarrassed over their insufficient knowledge; on the contrary, knowing self knowing nothing at all is a positive indication in the PBL process. (Socrates' wisdom)

3. The tutors' responsibilities are not merely promoting the initiation and progression of the discussions, but to concern the uniqueness as well as the present conditions of each learner. Each learning process is unique, because its success or failure depends on the present condition of each participant, hence spontaneity and flexibility of the tutors is necessary. (Socrates' midwifery skills)

4. Every student plays multiple roles in the PBL process, and every tutor or teacher should ensure that the students can change and have changed their roles flexibly. Especially when students are playing roles as critical thinkers, that means they are just developing a new idea. The more comprehensive and mature the criticism is, the more the approaching of new ideas is indicated. (Socrates' midwifery skills)

5. The appearance of critical thinking indicates an important shift-point between different phases has been reached. The thinking pattern begins shifting from the open-mindedness (truth of openness) to the searching for accurate facts (truth of correspondence). But in fact, these two different thinking ways could co-exist, and do not contradict each other, as consistent with the concept of Popper's Falsifiability. (Popper's Falsifiability)

6. One hypothesis should not dominate the discussion too quickly. Instead, various alternatives opposing the given hypothesis should be explored. (Popper's Falsifiability)

The final reminder is that PBL stimulates both wisdom of reasoning (*semiosis*) and wisdom of practice (*phronesis*). It is an education method that is most concerned with the differences and uniqueness of individuals. All participants should understand they are members of unique teams; everyone should be responsible for the outcome of the discussion in which they are involved.

ACKNOWLEDGMENTS

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