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Emotional literacy and problem-solving skills with pbl model and hpc strategy: Circulatory system concept

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ABSTRACT

Emotional literacy as a new 21st-century literacy is one-factor influencing student learning success. This study aims to analyze the differences in emotional literacy and problem-solving skills in Problem-Based Learning (PBL) model learning with Homogeinity psycho cognition (HPC) Strategy and PBL. This study included quasi-experiment research with a pretest-postest nonequivalent control group design. The research sample was 75 fifth-grade students taken randomly from several elementary schools in the Nusaniwe Sub-District based on the placement test. The research instruments were an emotional literacy questionnaire and a problem-solving skills test instrument consisting of 20 statement items and 8 problem items related to the human circulatory system. Data analysis used the Mann-Whitney U Test and one-way ANCOVA. The results showed no difference in emotional literacy between the treatment group (PBL with HPC strategy) and the control group (PBL). The ANCOVA test results concluded that students' problem-solving skills in the PBL model with the HPC strategy were superior to those in the PBL model. This finding helps develop appropriate and strategic science-biology learning in elementary schools.

INTRODUCTION

In this century, the educational landscape prioritizes emotional and social aspects as essential needs in human life (Salinas et al., 2023). Modern society now requires new values and ways of relating to each other at any given time to gain happiness (Sharif et al., 2021). Goleman (1998) Goleman (1998) states that a person's success is primarily determined by aspects of emotional intelligence, which reaches 80% compared to aspects of intellectual intelligence, whose contribution is only 20%. However, until now, learning has focused more on achieving intellectual aspects alone, while emotional intelligence is less considered (Drigas & Papoutsi, 2018). As a result, there is an imbalance between intellectual and emotional intelligence, which can trigger negative behavior in children (Louwen et al., 2023). If students' emotional intelligence is good, then intellectual intelligence is also good. Therefore, learning success can be pursued by fostering students' emotional literacy and empowering intellectual intelligence (Alemdar & Anılan, 2022).

Various phenomena in schools show students' weak emotional intelligence (EI) due to the lack of emotional literacy (Ghahari & Ebrahimi, 2017). Almost every day, students must commit aggressive acts such as showing anger towards their friends, making fun of weak friends, fighting, and not doing homework (Torregrosa et al., 2011). This can be seen from the results of research in South Korea, where students experience bullying at school and bullying from peers (Bong et al., 2021), resulting in impaired academic performance, decreased quality of life, and psychiatric illnesses such as depression and anxiety disorders in adulthood (Takizawa et al., 2014; Sourander et al., 2016). Elementary school students who are in childhood have emotional instability. Everyone has a different level of stress and its causes. One of the causes of stress in students is the number of important subjects (Pascoe et al., 2020). It is also due to academic failure, sports, finances, health, loss of family members and friends (Elias et al., 2011), and economic problems (Fenanlampir & Mutohir, 2021). Emotional intelligence makes children endowed with some valuable traits that help them realize emotions, manage feelings, overcome obstacles, and show empathy towards others (Zarifsanaiey et al., 2022).

Emotional literacy is one of the essential skills of the 21st century, as it is characterized by social, academic, and occupational success and thrives in modern society (Zeidner, 2017). The term emotional literacy was first coined by Steiner in 1977 in his book 'Healing Alcoholism' (Watanabe et al., 2022). This is marked by the practice of physical and psychological violence experienced by students in several schools labeled as "Child-Friendly Schools in Ambon City" (Leasa & Samallo, 2014). Emotional literacy is needed to reduce victimization, bullying, and violent activities (Knowler & Frederickson, 2013). The practice is directed at enforcing discipline through corporal punishment, which impacts elementary school students' learning motivation.

The external environment often influences the development of individual abilities by acting on internal factors. Student-teacher relationships can promote the development of emotional intelligence in school-age children. Children who learn early with teachers will manage their emotions and internalize them into themselves so that they have unique emotional processing patterns. Students can learn to express their emotions correctly and effectively through teacher feedback, thus enhancing emotional intelligence development (Xiang et al., 2022). Students who can maintain relationships and build social relationships at school well will be more successful in the future (García-Moya et al., 2019).

Emotional literacy has a relationship with problem-solving. Where emotionally literate students will be more confident, mentally healthy, able to regulate their emotions and behavior, aware of their own emotions and the emotions of others, able to manage their own emotions and the emotions of others, build positive things, solve problems and be able to show empathy (Camilleri et al., 2012). Problem-solving is considered a competency that begins to develop early, needs to be supported early, and is learned through attitudes and skills. Emotional literacy is a broad term that combines social problem-solving skills and emotion regulation skills. The results of previous research reveal that there is a significant correlation between children's emotion regulation skills and parents' emotional literacy skills. In addition, parents' emotional literacy level also predicted children's emotion regulation skills. However, there is no significant correlation between parents' emotional literacy skills and children's social problem-solving skills (Bozkurt et al., 2021).

Related to emotional literacy, biological science is one of the subjects that aims to develop scientific and rational thinking skills. The progress of science is now primarily determined by the development of science, including biological science. So far, the process and results of students'

biological science learning in Indonesia, including Maluku, have been below the minimum standard (Leasa et al., 2023a). In the World Bank report through the IEA (International Association for the Evaluation of Educational Achievement) study on the reading results of fourth-grade elementary school students, it was found that Indonesian students were only able to understand 36% of the reading material, making it the lowest position in Asia (Halimatussakdiah et al., 2023). Due to low thinking skills, students need help to answer questions in the form of descriptions that require reasoning and analysis (Leasa, Batlolona, et al., 2021).

One way to equip students with several values is to implement learning models or strategies with great potential to develop emotional literacy and problem-solving skills (Leasa et al., 2017). If students are well empowered with emotional literacy, they can self-regulate their learning and improve their learning outcomes and thinking skills, including problem-solving skills. One that has been used is the Numbered Heads Together (NHT) type cooperative learning model. The research report states that there is a relationship between emotional intelligence and the learning outcomes of elementary school students (Leasa, 2017).

In addition to cooperative models, learning models considered appropriate for building an emotional environment that supports elementary students' learning are based on constructivist approaches, such as the Problem-Based Learning (PBL) model. PBL is based on the idea that learning is not just a process of memorizing concepts or facts but a process of interaction between individuals and their environment. PBL can also develop higher-order thinking skills such as critical thinking, problem-solving, finding and using learning resources, independent learning, and cooperative working skills (Steck et al., 2012). PBL involves thinking activities to solve problems and correlates with learners' cognitive functions (Leasa et al., 2023b). PBL can potentially empower metacognitive skills (Akçay, 2009; Kuvac & Koc, 2019; Leasa et al., 2023c).

PBL has revealed various advantages, although there are some disadvantages. Research by Baena-luna et al. (2024) showed that using PBL is more time-consuming when compared to conventional strategies. Not all students can engage in PBL classes (Chueh & Kao, 2024). In addition, curriculum guides and textbooks must contain the necessary range of example problems or assessment tools (Erdogan & Senemoglu, 2017). This can result in students or even teachers needing help posing problems related to learning materials. PBL requires a lot of material and requires students to search for more information (Pimdee et al., 2024). Students also sometimes need help solving problems due to a lack of prior knowledge related to the topic discussed and a lack of interest in reading.

Another learning strategy is needed to overcome the shortcomings of PBL such as the Homogeinity Psycho Cognition (HPC) learning strategy. HPC is based on the homogeneous grouping of students, especially in terms of cognition, thus helping students to increase each other's confidence, emotions, and cognition. HPC is considered to be able to cover the weaknesses of PBL by encouraging students to work in homogeneous groups with more enthusiasm (Fenanlampir et al. 2021) HPC is considered to cover the weaknesses of PBL by encouraging students to work in homogeneous groups with more enthusiasm (Fenanlampir et al., 2021), use relevant strategies, and be more humanistic in learning so that there are no more severe problems in learning. Through PBL with HPC strategies, students' emotional literacy is expected to increase. Studies show that PBL can improve elementary school students' problem-solving skills (Leasa, Fenanlampir et al., 2021). This is because PBL, with the HPC strategy, students are highly valued, respected, and treated humanistically in learning. This situation impacts students' learning pleasure and comfort, so it can encourage better learning processes and the development of problem-solving skills. As a new approach, there needs to be more information that reveals the potential of PBL with HPC strategy on emotional literacy and problem-solving skills in elementary school students. Related to the above study, no research has been found on the effect of PBL with HPC strategy on emotional literacy and problem-solving skills in science-biology learning of elementary school students. Therefore, this study aimed to analyze the effect of the PBL learning model with HPC strategy on emotional literacy and problem-solving skills of science-biology of elementary school students.

METHODS

Research Design

This research is a quasi-experiment with a pretest-postest nonequivalent control group design (Kenny, 1975). Table 1 shows the procedure for implementing the treatment based on the research design.

Table 1
Treatment Group

Pretest	Treatment	Posttest
O1	S1	O2
O3	S2	O4

Description:
O1, O3 : pretest score
O2, O4 : posttest score
S1 : PBL model group with HPC strategy
S2 : PBL model group

Population and Samples

This study's population was fifth-grade elementary school students in Nusaniwe Sub-District, Ambon City, Indonesia. The research sample was determined by random sampling through the lottery technique. Each treatment group was represented by 3 classes, so 6 classes were used in the experimental group (PBL model with HPC strategy) and control group (PBL learning model). This was to fulfill the requirements of the data analysis techniques used (at least 30 students per treatment group).

Instrument

The research instrument is a learning implementation observation sheet to observe and ensure that learning occurs using PBL and PBL procedures with HPC strategies. The observation sheet contains statements of teacher and student activities during learning with both learning models. In addition, instruments were also used to measure the dependent variable, namely the emotional literacy questionnaire and the problem-solving skills test instrument. All instruments were developed and validated by experts. The emotional literacy questionnaire was developed from relevant emotional literacy theories.

Furthermore, a trial was conducted to ensure that the instrument met the criteria and was of good quality, with information on its validity and reliability. Emotional literacy assessment refers to the rubric Kliueva & Tsagari (2018) from the University of Cyprus and Oslo and Akershus University College of Applied Sciences, which contains 20 questions with 5 indicators, namely 1) building a learning environment, 2) building relationships, 3) responding to prevailing behavior, 4) building a cooperative environment, and 5) building emotional growth. Problem-solving skills assessment refers to a rubric of problem-solving skills consisting of 4 indicators: formulating problems, formulating hypotheses, collecting data, and formulating conclusions. Polya's problem-solving skills rubric (Brijlall, 2015) consists of 4 scales (1-4) as a reference to confirm the answers to each test item.

Procedure

This research was conducted following the following procedures. 1) Conducting a placement test to determine the sample schools. 2) Mapping schools/classes as treatment and control groups and mapping the science material taught, namely the human circulatory system. This concept is taught in 4 lessons, with 4 primary materials: the structure and function of human circulatory organs, the process of human blood circulation, disorders/abnormalities in the circulatory system, and how to overcome disorders/abnormalities in the circulatory system. 3) Equalizing perceptions with teachers who assist in learning in PBL and PBL groups with HPC strategies. 4) Conducting a pretest of problem-solving skills in the form of an *essay*. 5) Carrying out learning with the setting in the treatment group (PBL with HPC strategy) and the control group (PBL). 6) Observing the implementation of PBL model learning with HPC strategy and with PBL on teachers and students. 7) Carrying out the posttest of problem-solving skills followed by filling out the emotional literacy questionnaire by the teacher.

Data Analysis Techniques

The data obtained from this study was on emotional literacy and problem-solving skills. Emotional literacy data is ordinal, so it needs to be transformed with MSI (Successive Interval Method). The results of the questionnaire responses and student test results, both for informing emotional literacy and problem-solving skills, were reviewed. The data were analyzed with the assistance of the SPSS 16.00 program. Parametric statistical methods were conducted if the normality and homogeneity of the data were met.

RESULTS AND DISCUSSION

The data description describes the study's results, including data on emotional literacy and students' problem-solving skills.

Emotional literacy

Emotional literacy data was measured through questionnaires in each treatment group. The emotional literacy indicators used include 1) building a learning environment, 2) building relationships, 3) responding to disruptive behavior, 4) developing a cooperative environment, and 5) supporting emotional growth. Table 2 presents the data on emotional literacy.

Table 2
Emotional literacy Data Description

Indicators	Treatment Group			
	PBL HPC	SD	PBL	SD
Building a Learning Environment	87.50	2.66	90.62	2.09
Building Relationships	75.62	3.07	91.88	1.91
Responding to Disruptive Behavior	73.75	3.17	55.63	2.97
Developing a Cooperative Environment	88.12	2.59	88.12	1.96
Supports Emotional Growth	89.37	2.30	75.63	2.62
Total	414.36	13.79	401.90	11.55
Average	82.87	2.76	80.38	2.31

Emotional literacy data shows that emotional literacy in the PBL group with the HPC strategy is 2.49 higher than that of the PBL group. Indicators of building a learning environment and building relationships in the PBL group with the HPC strategy are much lower than in the PBL group, while the other 2 indicators, namely responding to disruptive behavior and supporting emotional growth, are higher than the PBL group. From the mean value of emotional literacy, it is known that both groups have the same trend. This trend proves that emotional literacy is highly considered in the elementary school environment. One form of school attention in maintaining emotional literacy in elementary schools is rejecting acts of violence or bullying in the school environment. In the era of the Merdeka Belajar curriculum, bullying is prohibited, so schools always strive to prevent bullying and keep the school environment safe and comfortable for all parties.

The requirements for testing the emotional literacy hypothesis with parametric statistics are typically distributed and homogeneous data. The Kolmogorov-Smirnov test results inform that the emotional literacy data of the PBL group with the HPC strategy ($D(10) = 0.394$, $p = 0.000$) and the PBL group ($D(10) = 0.223$, $p = 0.131$), which means that the emotional literacy data in the PBL group with the HPC strategy is not normally distributed, except for the PBL group. The Levene test results inform that the variance of emotional literacy data ($F(1,18) = 4.766$, $p = 0.042$), which means that the data is not normally distributed. Thus, it cannot fulfill the prerequisite test of the unpaired T-test, so the Mann-Whitney Test nonparametric statistics are used next. The Mann-Whitney U Test analysis results showed that emotional literacy in learning with PBL alone and PBL with HPC strategy was the same or not significantly different ($U = 48.500$, $p = 0.646$).

Problem-solving Skills

The problem-solving skills data used is the average of pretest and posttest data. This data was obtained in 2 treatment groups, the PBL group with the HPC strategy and PBL alone. The following presents the average data of problem-solving skills.

Table 3
Data Description of Problem-solving Skills

No.	Indicators	Pretest				Posttest			
		PBL HPC	SD	PBL	SD	PBL HPC	SD	PBL	SD
1	Formulating a problem	50.64	25.32	57.29	31.25	85.26	16.19	62.85	25.61
2	Formulating a hypothesis	48.08	31.87	57.99	31.07	72.11	32.50	68.40	27.46
3	Collecting data	40.06	24.70	52.78	16.93	79.17	21.90	72.22	18.20
4	Making conclusions	27.24	22.37	40.28	25.72	52.88	21.74	59.72	26.07
Average		41.51	26.06	52.08	26.24	72.36	23.08	65.80	24.34

Table 3 shows that the lowest problem-solving indicator is making conclusions from the pretest and posttest data in the PBL with HPC and PBL groups. The table also shows that the mean of pretest and posttest data of problem-solving skills are 46.78 and 69.08, respectively. The pretest data in the PBL group was 10.57 points higher than the PBL group with the HPC strategy, while the posttest data of the PBL group with the HPC strategy was 6.56 points higher than the PBL group. The difference between the pretest and posttest in the PBL group with the HPC strategy is 17.13 points higher than in the PBL group.

Before testing the hypothesis, it is necessary to ensure that the problem-solving skills data meets the requirements of the hypothesis test or not. The normality test uses residual data on problem-solving skills. The Kolmogorov-Smirnov test results inform that the residual data of problem-solving skills are typically distributed ($D(75) = 0.077$, $p = 0.200$). The Levene test results inform that the variance of problem-solving skills data between the PBL learning model group and the PBL model with HPC strategy is homogeneous, where ($F(1,73) = 0.079$, $p = 0.780$). These results prove that the normality and homogeneity of problem-solving data meet the research hypothesis prerequisite test criteria. Hypothesis testing of differences in problem-solving skills using PBL and PBL learning models with HPC strategies using one-way ANCOVA is visualized in Table 4.

Table 4
ANCOVA Test for Differences in Problem-solving Skills based on Learning Model

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3356.579[a]	2	1678.289	6.534	.002	.154
Intercept	34488.057	1	34488.057	134.275	.000	.651
X_PM	2551.687	1	2551.687	9.935	.002	.121
Model_Learning	1617.441	1	1617.441	6.297	.014	.080
Error	18492.901	72	256.846			
Total	381083.984	75				
Corrected Total	21849.479	74				

a. R Squared = .154 (Adjusted R Squared = .130)

The one-way ANCOVA test results showed a difference in problem-solving skills between the PBL group with the HPC strategy and the PBL group, taking the pretest of problem-solving skills as a covariate. The test results show that ($F(1,72) = 6.297$, $p = 0.014$, $\eta p^2 = 0.080$). This significance value is smaller than alpha (0.05). The conclusion of the hypothesis test results means that the alternative hypothesis is accepted, meaning that the implementation of the learning model significantly impacts problem-solving skills. The magnitude of the difference between the treatment levels of the PBL model with HPC strategy and PBL was analyzed by further tests in Table 5.

Table 5
Results of Least Significance Different (LSD) Further Test for Differences in Problem-solving Skills

Model	X-PM	Y-PM	Difference	PM Corrected	LSD notation
PBL with HPC	41.75	72.36	16.57	73.82	a
PBL	52.08	65.80	17.41	64.21	b

The data in Table 5 indicate that students' problem-solving skills in learning with PBL with HPC strategy are significantly different from those in the PBL learning model treatment. The LSD test results ensure that the PBL learning model with HPC strategy is superior to PBL.

The data above aligns with previous findings that show that HHPC learning strategies influence elementary school students. Therefore, emotional skills are determined by learning strategies. Student cooperation can foster adequate emotional skills in all students (Fenanlampir et al., 2024). In a changing world, emotional literacy is needed to give us the right to develop skills in solving various biological science problems. Emotional literacy is recognizing, understanding, and expressing one's emotions. Today, the need for emotional literacy is increasing, and it helps children become emotionally literate. This is one of the best investments for a child's life. Emotional literacy helps lay the foundation for a better society. Various studies underscore the importance of emotional literacy in students. Emotional literacy is critical to helping students achieve self-actualization and live better lives. Children will mature emotionally and improve their skills in managing their feelings that affect their ability to fulfill their potential so that they can live in the future, solve learning difficulties, face challenges, and gain knowledge about how they feel about themselves (Jan & Anwar, 2019).

Emotional literacy is defined by the "Southampton Educational Psychology Service" as the ability to recognize, understand, handle, and express emotions appropriately (Sharp, 2000). Emotional literacy is also related to emotional intelligence (Pearson & Wilson, 2008). While EI is an individual potential, emotional literacy includes individual and social dimensions of personal experience. Emotional intelligence is perceived as potential, while emotional literacy is considered the use of potential in interpersonal relationships (Kliueva & Tsagari, 2018). The study results show a relationship between emotional literacy and problem-solving ability. Students with good emotional literacy can solve problems well and live in the future (Aktepe & Gündüz, 2022). Emotional literacy can be considered a factor that can be learned and taught as an indicator that can preserve and improve problem-solving skills. Previous studies have shown that students with high emotional control can achieve high math and science learning achievement. Students with adequate management skills and emotional control can excel in math and science, which require a high cognitive load (Pishghadam et al., 2022). Emotional literacy skills acquired in the family environment, such as in expressing emotions and understanding the emotions of others, may vary depending on social and cultural characteristics. It can be seen that emotional literacy skills among high school students and that the average score is higher for female students than male students (Çetin, 2023). Study results in Oksuz (2016) concluded that 1) Socio-emotional learning should be included in the school curriculum; 2) Emotional literacy activities can be designed for younger students, such as in year 1, year 2, and year 3 as in the Turkish education system. The role of schools in the development of emotional literacy should be more widely understood as the responsibility of all people, institutions, and individuals who work with children and adolescents, especially those who have a professional interest in providing assistance and support in the development of children (Jelena & Stanislava, 2018).

A person does problem-solving to identify answers effectively to real-life problems that he or she faces in everyday life. Problem-solving skills are considered a competency that begins to develop early, needs to be supported early, and is learned through attitudes and skills (Bozkurt et al., 2021). In a previous study, it was found that older people have a higher level of emotions when compared to young people, whereas women are more successful in understanding feelings than men, and men are more successful in controlling their feelings than women (Baron, 2006; Delhom et al., 2024). People with good problem-solving skills are often less affected by the adverse effects of stress, such as hopelessness, anxiety, and depression (Kupferberg & Hasler, 2023).

Developing emotional literacy triggers self-awareness and helps one achieve personal and academic success. These skills empower individuals to manage their emotions and actions effectively, make wise choices, and cultivate meaningful relationships with others (Tagata, 2022). These skills are positively associated with academic achievement, improved social-emotional well-being, and increased resilience in the face of challenges in the face of adversity. An investigation by Orbach (2008) exploring early career science teachers' experiences of social bonding and emotion management highlighted the importance of social bonding with colleagues and students for early career teachers' emotional well-being and professional development. Therefore, teacher education programs should prioritize the development of emotional skills and promote supportive social networks for teachers' career development. Developing emotional literacy and self-awareness in

students can provide many benefits beyond the classroom. For example, it improves the mental health and emotional well-being of families. In addition, students can develop greater self-awareness and become more motivated to learn and take ownership of their academic progress (Peseyie, 2020; Bıdık & Sisman, 2021). Emotional literacy and self-awareness can also provide social benefits for students. Students can improve their communication skills and develop stronger relationships with their peers by developing greater empathy and understanding of their own and others' emotions. This can lead to more positive (Bernard, 2023). Every teacher should apply problem-based learning to their students to stimulate them to think and solve problems. Hopefully, students will be trained to think, analyze, receive information, actively process information, and draw conclusions. The data above shows that higher-education students achieve better than students with low academic ability. However, both groups are in the low problem-solving category because teachers are not accustomed to providing problem-solving exercises. Therefore, students with high and low academic levels still need appropriate learning strategies to improve the skills of both groups. In addition to using appropriate learning strategies, learning modules can also be provided to academically weak students by providing problem-based modules that guide them in solving problems in a guided manner so that their ability to understand problems increases (Aji et al., 2019).

Problem-solving skills are essential to apply to see how well students can think, analyze, and act to implement solutions. Most students needed help implementing the solution due to several factors, such as reluctance to analyze. Although they can go through the five problem-solving steps, most are still trying to figure out the answer. Thus, there needed to be a concrete indicator of their problem-solving ability. Learning biological science requires good problem-solving skills and emotional literacy because learning biology is limited to concepts and facts and procedural and metacognitive biological learning processes (Sung et al., 2020). Biological science learning reflects thinking skills that use logical principles, empirical evidence, and scientific methods to gain new knowledge about the circulatory system in humans.

Studying the human circulatory system is an important and challenging topic in science-biology learning in primary school. Previous studies have identified students' difficulties related to concepts, and some have analyzed students' language difficulties. Language can hinder science learning and study (Seah, 2021). The human body is a complex system that is relevant and interesting to students but also very difficult to understand (Estrada, 2023). For example, the human circulatory system is a complex system consisting of various cells forming organ tissues that work together. All represent different levels of hierarchy. The components of the circulatory system have various functions. For example, the function of blood is to transport oxygen, carbon dioxide, nutrients, vitamins, and immune defenses or to transport hormones. The various blood vessels (arteries, veins, and capillaries) have different structures that serve their functions. The circulatory system also interacts with other systems in the body to maintain homeostasis (Wang, 2004; Gnidovec et al., 2020), as shown in Figure 1.

The human circulatory system is a complex and multicomponent organ system, consisting of the heart as its center and a network of large to small blood vessels distributed throughout the body (Figure 1). It is dynamic and highly responsive to biophysical and biochemical cues (Gimbrone et al., 2000). Changes in the geometry, composition, and stiffness of blood vessels and heart valves due to accumulation of fat, cholesterol, calcium, chronic aging, or genetic abnormalities can alter the state of physiologic flow patterns and lead to a cascade of molecular and cellular events that impair their function (Paneni et al., 2017). Studying the human circulatory system is challenging. At the system level, students must appreciate the primary function of the entire system, namely, to facilitate the transportation and exchange of materials. At the organ level, students must relate the structure and function of each organ. Meanwhile, they must appreciate how the functions and structures of individual organs/tissues are organized differently to serve the system's functions (Cheng & Gilbert, 2015).

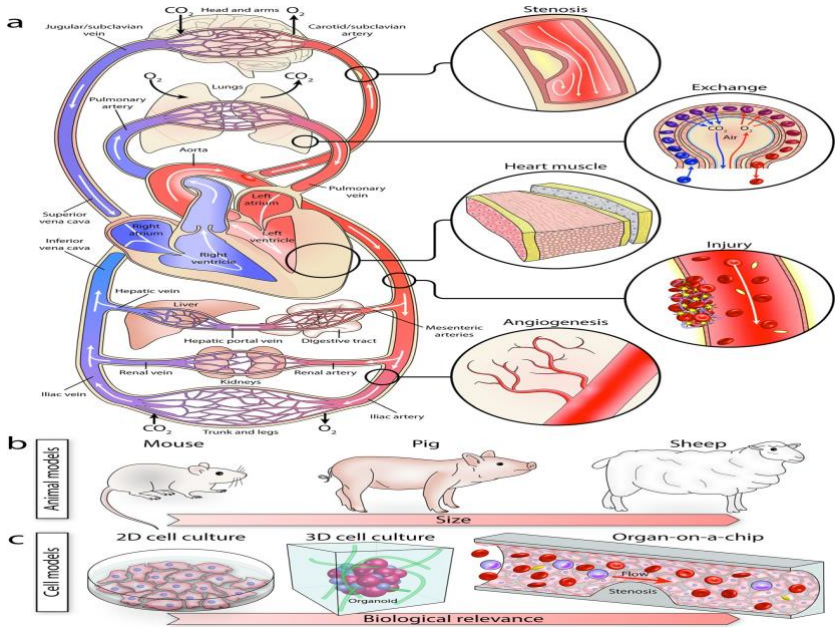

Figure 1 is a Schematic of the human circulatory system, consisting of the heart at the center and a complex network of vessels interacting with other organs. **b** Animal models are extensively used to study the human circulatory system. **c** the complexity, cost, and inherent differences between the human and animal models have led to the evolution of cell models, ranging from simple 2D models (Petri dis, flasks) to more complex 3D models (hydrogels, spheroids, organoids) and more physiologically relevant microfluidic models.

Source: (Nguyen et al., 2021)

CONCLUSION

Based on the findings, it can be concluded that there is no difference in emotional literacy between PBL treatment groups with HPC and PBL strategies. The results of the one-way ANCOVA test also concluded that there were differences in problem-solving skills in learning with the PBL model and the HPC strategy with the PBL model. Problem-solving skills in the PBL group with the HPC strategy are higher than in the PBL model. Suggestions that can be conveyed from the results of this study are: 1) The learning environment that continues to support emotional literacy in PBL models with HPC or with PBL needs to be pursued by schools; 2) Teachers can use PBL learning models with HPC strategies and PBL models to continue to develop students' problem-solving skills; 3) In order to develop learning outcomes, the problem-solving process in the context of PBL needs to be trained in a more guided manner and implemented continuously in learning; 4) It is necessary to conduct a more specialized study to explore the use of the HPC strategy in a relatively long time learning to get more information about students' cognitive development in science learning and other thematic learning in elementary school.

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