

# Situated learning makes easy learning for the biomedical engineering students in blood physiology

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## Research Article

**Keywords:** Situated learning; Blood physiology; Undergraduate

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1 **Title:** Situated learning makes easy learning for the biomedical engineering students in  
2 blood physiology

3 **Running title:** Situated learning improves learning in blood physiology

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29 **Abstract**

30 **Background**

31 Blood physiology is difficult to be understood and remembered for biomedical  
32 engineering students by traditional teaching method. In this study, we aim to know  
33 whether situated learning was helpful for students learning the key points of theoretical  
34 knowledge in blood physiology.

35

36 **Methods**

37 In the study group (2019), 51 sophomores were randomly divided into two smaller  
38 teams. Team A was provided with the script of wisdom tooth extraction, which contains  
39 the knowledge of hemostasis and coagulation. Team B was provided with a script of  
40 rescue in the intensive care unit, which contains the knowledge of blood type and blood  
41 transfusion. In the control group(2018), 52 sophomores participated in traditional  
42 lectures given by the teacher with the aid of PowerPoint slides. After class, students  
43 from both groups completed the theoretical test, and their test scores were compared.  
44 In addition, we designed a questionnaire to get feedback from the study group.

45

46 **Results**

47 The theoretical test showed the scores in the study group were higher than those in the  
48 control group(2018). The questionnaire analysis showed the positive role of situated  
49 learning in learning the key points.

50

51 **Conclusions**

52 To sum up, situated learning makes easy learning for undergraduate in blood physiology.

53

54 **Keywords:** Situated learning; Blood physiology; Undergraduate

55

## 56 **Background**

57 Physiology is a medical professional course offered by our school for biomedical  
58 engineering students. The original purpose of this course is to help students to better  
59 understand the concept of a “combination of medicine and engineering” and to establish  
60 a solid medical foundation. Blood physiology involves lots of knowledge, including  
61 hemostasis, coagulation, blood type, and blood transfusion, which are the key points of  
62 learning but also are difficult to be understood and remembered. Moreover, for those  
63 engineering students without a medical background, it is a quite difficult task to quickly  
64 grasp this knowledge in a short period of time. Lave and Wenger's situated learning  
65 theory opened new territory by illuminating social and cultural learning processes[1].  
66 Situated learning is centered on the learner, and the learner is placed in the teaching  
67 situation. Situated learning used scenario which simulated essential aspects of a medical  
68 situation so that a student can consolidate learning in a safe and secure environment[2].  
69 The clinical situation is a component of the simulation typology that uses a prewritten  
70 scenario, which has been proved to enhance basic knowledge learning in many medical  
71 courses[3-5].

72  
73 Few studies discussed the effect of applying simulated teaching program to physiology  
74 course, for example, blood physiology. Therefore, it is important to know about whether  
75 situated learning could make biomedical engineering students easy earning of blood  
76 physiology. Therefore, we attempted to create a simulated teaching program for  
77 biomedical engineering students. 51 sophomores who participated in the situated  
78 learning in 2019 were taken as the study group. 52 sophomores who only participated  
79 in traditional lectures in 2018, during which the same teacher gave lectures with the aid  
80 of PowerPoint slides, were taken as the control group. After class, students from both  
81 groups completed the theoretical test, and their test scores were compared. In addition,  
82 we designed a questionnaire to get feedback from the study group.

83

84 **Methods**

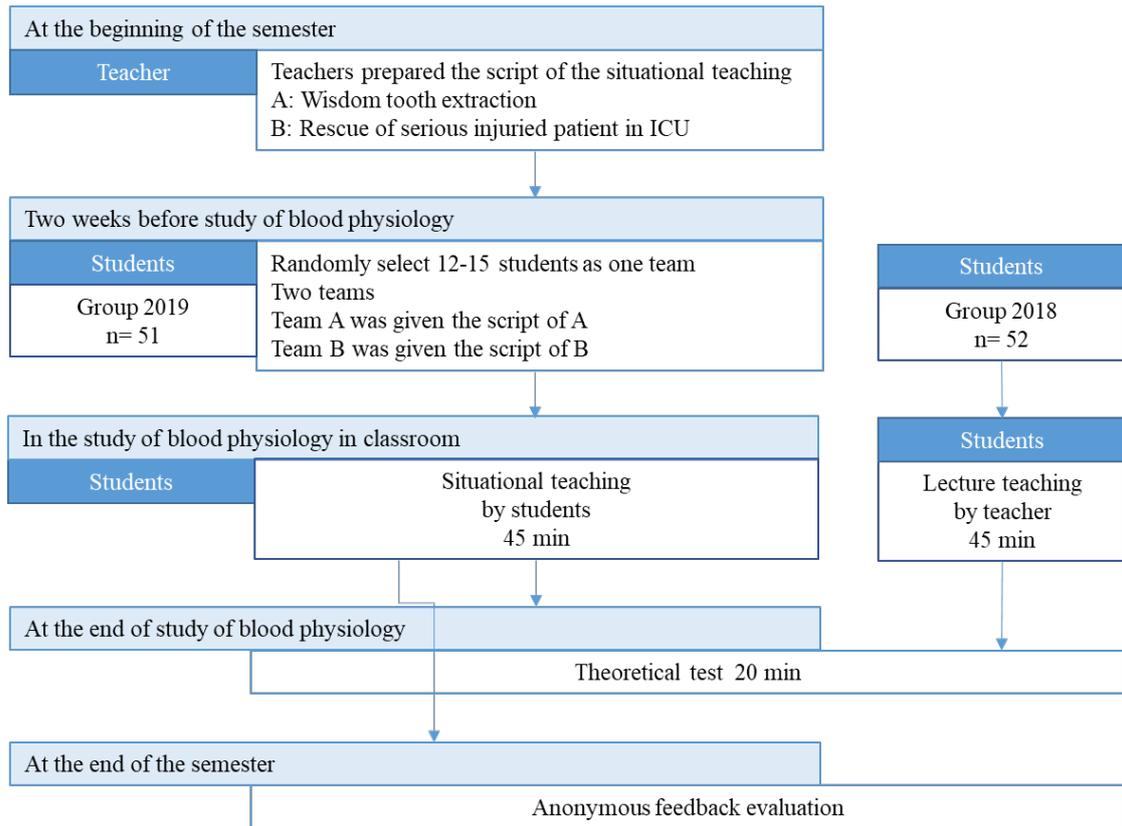
85 **Intervention design and procedures**

86 Institutional approval was obtained before the study was initiated. All methods were  
87 carried out in accordance with relevant guidelines and regulations in Zhejiang  
88 University. The study involved students from biomedical engineering in the second  
89 professional year at Zhejiang University. These biomedical engineering students never  
90 had medical courses or training over the past. Students in 2019 received as a study  
91 group 2019(n=51), while students in 2018 received traditional teaching as a control  
92 group 2018(n=52). Students in both groups came from the same specialty and had taken  
93 the same professional courses before. All students agreed to participate in the study.  
94 Meanwhile, the teaching team consisted of an associate teacher and one assistant from  
95 senior classes. During our class, the teacher supervised the overall process and the  
96 theoretical knowledge involved, while one assistant helped to coordinate the  
97 performance order. The overall study process is shown in Figure 1. The design and  
98 approach of situated learning are shown in Table 1.

99

100 Study group 2019 was further randomized and divided into two smaller teams by  
101 picking numbered lots. Team A was provided with the script of wisdom tooth extraction,  
102 which contains the knowledge of hemostasis, coagulation. Team B was provided with  
103 a script of rescue in the intensive care unit, which contains the knowledge of blood type,  
104 and blood transfusion. Each team was asked to study the script and prepared for the  
105 performance for 2 weeks, after which they were required to role play in the class to  
106 mimic the clinical situation in 20 min. After the performance by students, the teacher  
107 made a short summary and evaluation in 5 min.

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111 Figure 1. The time flow chart of preparing, performing and evaluating of situated

112 learning.

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126 Table 1 The design and approach of situated learning.

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	design and approach
Situated learning	Team A: Wisdom tooth extraction Team B: Rescue of serious injured patient in ICU
Key points of knowledge	Hemostasis and blood coagulation Blood type and blood transfusion
Students in team (Before class)	1) According to the script, assign roles of 2 doctors, 2 nurses, 1 patient, 2 family members 2) Actors rehearse for presentation 3) Prepare PPT slides, including the key points and expanding knowledge; 4) Search for videos which related to key points, for example, the animation of hemostasis, coagulation, and blood type determination
Students in team (In class, 20 min/team)	1) Performance 2) Team members ask and answer questions when they were acting as patients' families members, doctors and nurses 3) The team explains knowledge points through PPT and videos, and answer questions after performance
Students not in team (In class)	1) Watch the performance and videos given by team members; 2) Listen to the dialogue between doctor and nurse, family member and doctors, family member and nurses

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- 3) Listen to the interpretation given by team members with PPT slides, videos
- 4) Ask questions if he does not understand
- 5) Comment on the presentation

Teacher and assistant

- 1) Prepare the main script before class
- 2) Supervise the process in class
- 3) Make a brief summary before the end of the class in 5 min
- 4) Prepare theoretical test questions and feedback evaluation after class

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130 **Script of situated learning for team A: Wisdom tooth extraction**

131 Key points: Hemostasis and coagulation

132 Place: Stomatological hospital

133 Characters: 2 doctors, 2 nurses, 1 patient, 2 family members

134 Script: Students act as patients, doctors, nurses, and family members. Students act as  
 135 doctors and nurses were wearing white coats. Students simulated the process of patients  
 136 entering a stomatological hospital for wisdom tooth extraction. A student acted as the  
 137 patient and he wanted to have his wisdom tooth pulled out. He was told by the nurse  
 138 that he had to do a series of examinations, including clotting time and bleeding time.  
 139 The family members could not understand why he had to do these examinations. They  
 140 asked the nurses: (1) what is the clotting time test? (2) What is the bleeding time test?  
 141 (3) Why these tests were needed to be done before the operation? In the whole process,  
 142 through the dialogue between nurses and their families, patient, and doctors, the  
 143 relevant guiding questions and answers are given: (1) The process of physiological  
 144 hemostasis; (2) The process of blood coagulation; (3) Which factors can affect blood  
 145 coagulation? After the performance, the team asked questions to the rest student, such  
 146 as “After the tooth was extracted by the doctor, what kind of treatment should be done

147 by the doctor to help the patient to stop bleeding?” “What should the doctor tell the  
148 patient to do to avoid subsequent bleeding?”

149

150 Script of situated learning for team B: rescue in the intensive care unit

151 Key points: Blood type and blood transfusion

152 Place: The emergency room in the hospital

153 Characters: 2 doctors, 2 nurses, 1 patient, 2 family members

154 Script: Students act as patients, doctors, nurses, and family members. Students act as  
155 doctors and nurses were wearing white coats. A traffic accident seriously injured patient  
156 was sent to the hospital for emergency treatment. Doctor A and two nurses are giving  
157 emergency treatment to the patient. Due to excessive blood loss, blood transfusion was  
158 needed. The blood type of the patient was A. The family members worried about this  
159 patient. They asked the nurses: (1)What was the harm of excessive blood loss? (2)What  
160 kind of blood type can be transfused to this patient? (3) The blood type of his sister is  
161 A. She asked whether her blood could be transfused to the patient right now? Through  
162 the doctor's diagnosis and treatment, the dialogue between doctors, nurses, and the  
163 family members, besides the above three questions, the other relevant guiding questions  
164 and answers are given: (1) What is blood type? (2) What are the criteria for judging the  
165 need for blood transfusion? (3) What principles should be followed during blood  
166 transfusion?

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168 Questionnaire and feedback

169 To assess the understanding of blood physiology, at the end of the learning of the whole  
170 blood physiology, students in both groups were asked to complete a theoretical test in  
171 the form of 25-single choice questions in 20 min. The questionnaire was structured to  
172 determine cognitively and recall memory knowledge of blood physiology. It also tested  
173 the students' conceptual understanding, as it required them to analyze the information

174 learned and apply it to the clinical scenario. Moreover, to assess student compliance  
175 and qualitative superiority of the new teaching-learning method, at the end of the  
176 semester, students in study group 2019 were asked to provide their feedback by means  
177 of a form based on a Likert scale template. Feedback was collected and was kept  
178 anonymous. Investigators analyzing the data were not involved in the administration of  
179 the questionnaire and collection of feedback to reduce bias. The scores between control  
180 group and study group were compared using unpaired t-test, and P-value < 0.05 was  
181 considered significant.

182

### 183 **Results**

184 In total, 103 participants successfully completed the theoretical test, with 51 and 55  
185 were included in the study and control groups, respectively. The results was shown in  
186 Table 2. Group 2019 students achieved a higher total score in blood physiology than  
187 group 2018 students ( $P<0.01$ ). Interestingly, group 2019 students achieved higher  
188 scores in questions related to hemostasis and blood coagulation than group 2018  
189 students( $P<0.01$ ). Meanwhile, group 2019 students achieved higher scores in questions  
190 related to blood type and blood transfusion than group 2018 students( $P<0.01$ ).

191

192 Table 2 Comparison of the scores of the theoretical test of students in group 2018 and  
193 group 2019.

	Group 2018	Group 2019
	Lecture by teacher	by students
Total score	74.15±7.22	83.37±5.79**
Sub-score A	21.79±4.11	25.19±4.19**
Sub-score B	23.88±4.13	28.53±2.67**

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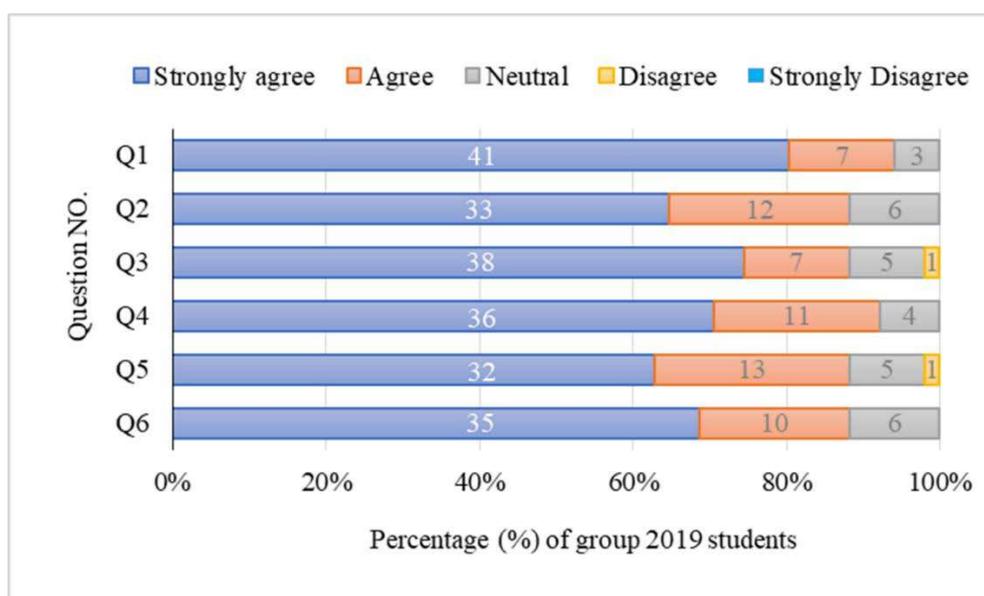
195 Total score of blood physiology: 25-single choice questions in blood physiology. Each  
196 question has 5 points. The full score is 100. Sub-score A: 6-single choice questions

197 related to hemostasis and blood coagulation(NO.14, 15, 16, 17, 18, 19). Sub-score B 6-  
 198 single choice questions related to blood type and blood transfusion(NO. 20, 21, 22, 23,  
 199 24, 25). Data were presented as Mean±SD. Data were analyzed and compared using  
 200 GraphPad Prism 8 software. \*\* $P < 0.01$ , t-test, compared with group 2018.

201

202 The results of the feedback were shown in Figure 2. The majority of the students in  
 203 study group showed agreement/strong agreement approved the students' performance  
 204 and thought that the students' performance was correct(94.12%). Importantly, the  
 205 majority of the students in study group showed agreement/strong agreement toward  
 206 liking situated learning(88.24%). There was agreement/strong agreement that situated  
 207 learning helped them better their conceptual understanding of blood physiology  
 208 (88.24%). 92.16% of students thought situated learning helped them to appreciate the  
 209 importance of principles of blood transfusion. When asked whether they were likely to  
 210 use situated learning in future courses or voluntarily recommend its use to next year's  
 211 students, most students gave a positive response(88.24%, 88.24%). Although a very  
 212 small percentage of students did have a less than enthusiastic approach toward the  
 213 question 3 and question 5(1.96%, 1.96%), none of the students reported any strongly  
 214 disagree regarding the use of situated learning (0%).

215



216

217 Figure. 2. Student feedback to questions based on Likert scale template. The questions

218 are as follows. Q1, The content presented by students in situated learning is correct. Q2,  
219 I like the situated learning. Q3, The situated learning helped me understand the blood  
220 physiology better. Q4, The situated learning helped me appreciate the importance of  
221 principles of blood transfusion. Q5, I hope there will be situated learning in future  
222 courses. Q6, I am likely to recommend situated learning to next year's students.

223

## 224 **Discussion**

225 According to 5 years of teaching observation, we found that among the knowledge  
226 points in blood physiology, hemostasis, coagulation, blood type and blood transfusion  
227 are difficult to be understand and remembered for those bioengineering students with  
228 no medical background. In our study, it is interesting to find that the test scores are  
229 significantly better than those of the control group, which proves that the situated  
230 learning can significantly improve test performance. Situated learning exploration  
231 made the students master the basic knowledge and basic application of these key points  
232 and difficulties more firmly in blood physiology. Our results was consisted with  
233 previous reports in medical education[3-5]. This better performance in our study adds  
234 merit to the hypothesis that knowledge acquisition and retention are better while using  
235 situated learning in blood physiology.

236

237 It is also worth noting that situated learning method was welcomed by the students in  
238 study group. As for the students who were not in teams, they felt the topic of situational  
239 learning more enjoyable and easier to understand due to inclusion of role play in the  
240 classroom. As for the students who were in teams, the creation of group discussion  
241 situation is helpful to change the students' learning method of reciting and memorizing  
242 by rote. It can improve the students' ability of practice, self-study, thinking and  
243 communication, and really integrate theory with practice. Furthermore, in the process  
244 of role playing, they will memorize the knowledge by heart.

245

246 We believe that learning is enhanced when the environment seems realistic[6]. Medical  
247 simulation replicates medical conditions, such as normal physiology and abnormal  
248 pathology. As for the two scripts, we designed them carefully based on the principle as  
249 follows: The script should closely mimic the medical condition, which exactly  
250 contained the physiological knowledge of key points, so as to stimulate students'  
251 interest, attract their attention, and let them experience the value of learning. On the  
252 other hand, it should not be very difficult to operate or perform. Thus, they can fully  
253 prepared and confident to role play well within two weeks.

254

255 This study delivered a practical and useful strategy to teach and learn in physiology  
256 course. However, the implementation of situated learning in the basic course of  
257 physiology, which have a higher requirement for teachers. Teachers not only have a  
258 good understanding of relevant professional knowledge, but also need to better  
259 integrate relevant knowledge into the situated learning, for example, script writing and  
260 editing. In addition, teachers are required to devote more time and energy to make a lot  
261 of preparation, and communication with team members.

262

263 There are some limitations in our study. First, we only compared the immediate impact  
264 of situated learning and traditional lecture on students' quiz scores. The participation of  
265 more students will help to obtain more objective results. Second, more key points of  
266 knowledge should have been included for better interpretation. Third, the study was  
267 conducted with two different classes across the years. Students had personal  
268 preferences on different pedagogical models. The interpersonal variation might have an  
269 impact on the effectiveness of situated learning or the traditional lecture. Thus, we  
270 believe that implication of situated learning should also be assessed prospectively on  
271 the same batch of students in regards to their knowledge, attitude, and practice in  
272 upcoming years of the blood physiology courses for reaching a more convincing  
273 conclusion.

274

275 **Conclusions**

276 Taken together, situated learning by students themselves enhances student learning,  
277 promote active learning and peer collaboration in teams. Situated learning has better  
278 acceptability by the students as it is more practically oriented and interesting. Our  
279 findings suggest that situated learning makes easy learning for the biomedical  
280 engineering students in blood physiology.

281

282 **Ethics approval and consent to participate**

283 The World Medical Association Declaration of Helsinki guidance was followed in the  
284 study. The study was approved by the Institutional Review Board (IRB) committee of  
285 Zhejiang University (Approval No. 2018-Zdjg08058). Informed consent was obtained  
286 from all individual participants included in the study.

287

288 **Consent for publication**

289 Not applicable.

290

291 **Availability of data and materials**

292 The datasets used and/or analysed during the current study available from the  
293 corresponding author on reasonable request.

294

295 **Competing interests**

296 No conflicts of interest, financial or otherwise, are declared by the authors.

297

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300 projects in the 13th five-year plan of higher education in Zhejiang University(No.

301 Zdjg08058, Research on Situated learning Design and Practice of Medical Physiology).

302

### 303 **Authors' contributions**

304 L.W. and Y.C. conceived and designed research; L.W. and M.Z. performed interpreted  
305 results of experiments; M.Z. and J.Z. prepared figures; L.W. and Y.C. drafted, edited,  
306 and revised manuscript; Y.C. approved the final version of the manuscript.

307

### 308 **Acknowledgments**

309 Not applicable.

310

### 311 **Abbreviations**

312 Not applicable.

313

### 314 **Reference**

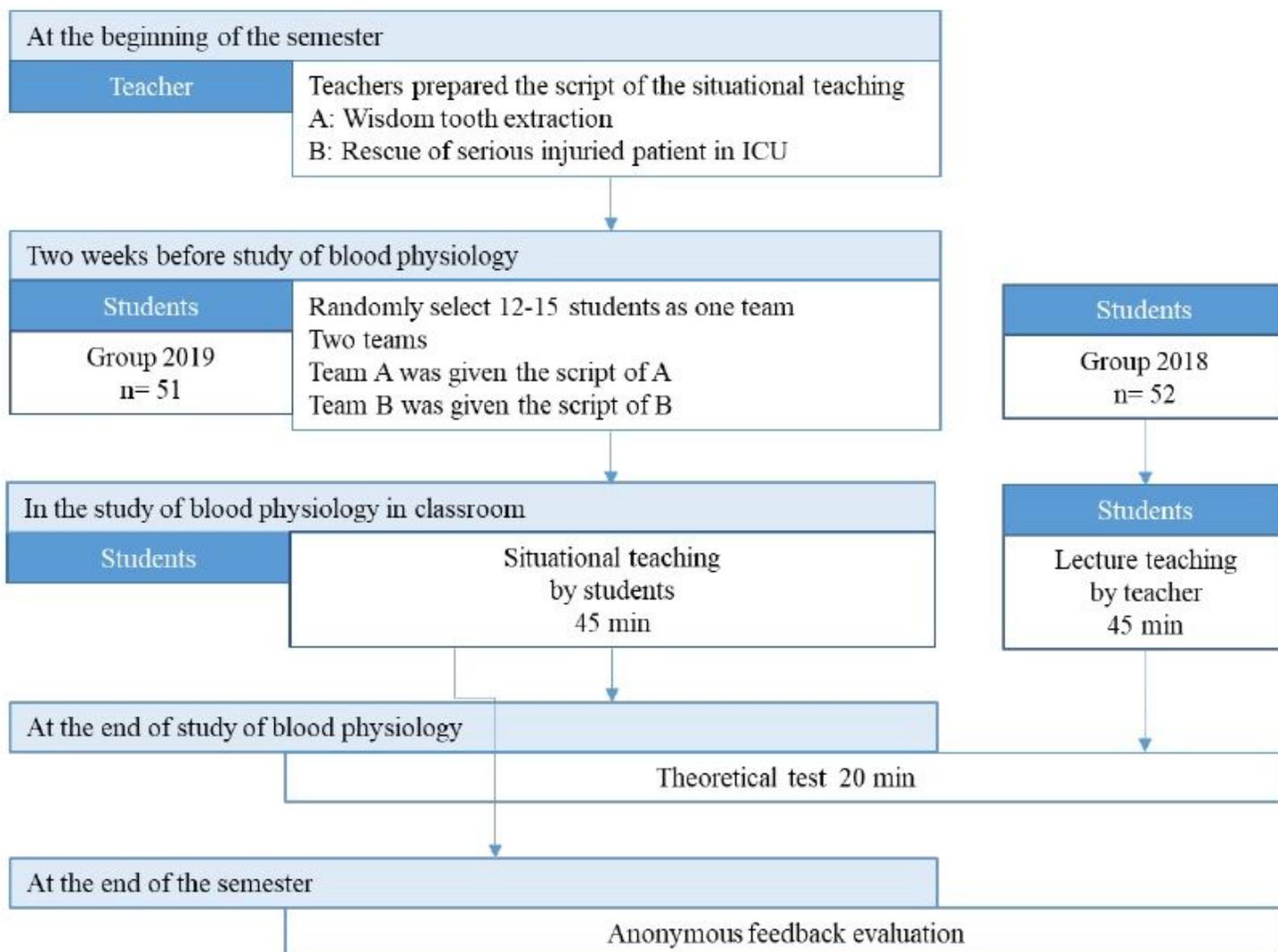
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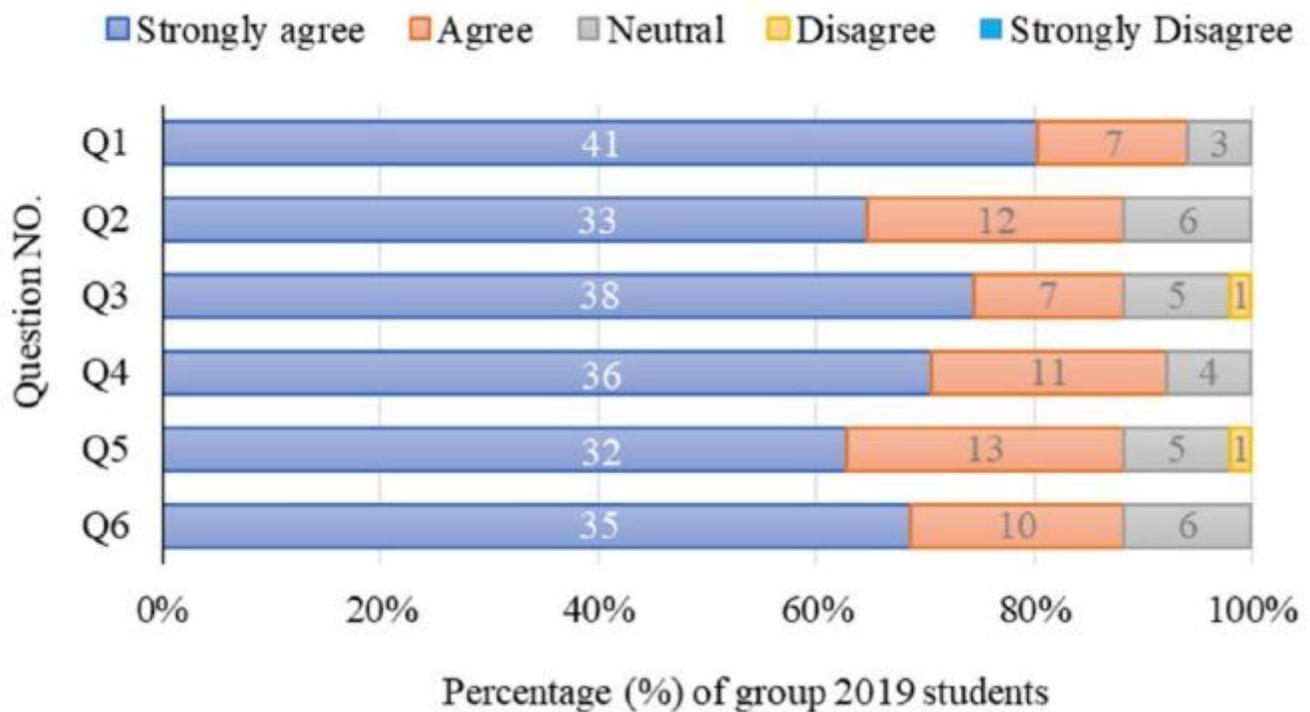
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# Figures



**Figure 1**

The time flow chart of preparing, performing and evaluating of situated learning.



**Figure 2**

Student feedback to questions based on Likert scale template. The questions are as follows. Q1, The content presented by students in situated learning is correct. Q2, I like the situated learning. Q3, The situated learning helped me understand the blood physiology better. Q4, The situated learning helped me appreciate the importance of principles of blood transfusion. Q5, I hope there will be situated learning in future courses. Q6, I am likely to recommend situated learning to next year's students.