

# A Computer-Assisted, Real-Time Feedback System for Medical Students as a Tool for Web-Based Learning

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**Objectives:** Medical students sometimes do not receive proper feedback from their instructors. This study evaluated a newly developed automated and personalized real-time feedback system intended to address this issue.

**Methods:** Third- and fourth-year medical students participated in quizzes focusing on 17 learning objectives and a five-scale survey that queried their prior knowledge related to blood transfusions. Immediately after completing the quizzes, the students received automated and personalized, real-time feedback and were instructed to take part in self-directed learning. This activity was followed by a final quiz. After completion of the final quiz, the students responded to the five-scale survey that probed the usefulness of and satisfaction with the automated, personalized, real-time feedback system.

**Results:** Eighty students took part in this study. The third-year group had a higher score for prior knowledge and also on the first quiz ( $P = 0.008$ ,  $P = 0.046$ , respectively). There was no significant difference in final quiz scores between the third- and fourth-year groups ( $P = 0.633$ ). The scores for usefulness of and satisfaction with the automated, real-time feedback system were 4.45 and 4.34, and 4.55 and 4.40 in the third- and fourth-year students, respectively.

**Conclusions:** The automated, personalized, real-time feedback system provided timely and effective feedback for medical students and was helpful for their self-directed learning.

**Key Words:** Automated, Feedback, Personalized, Real-time

Feedback is a basic teaching method that ensures standards are met.<sup>1,2</sup> Trainees are expected to improve their performance through feedback that contains specific information about the comparison between a trainee's observed performance and a standard.<sup>3</sup> Timely feedback needs to be provided because delayed feedback could cause decreased accomplishment in learning.<sup>4</sup> Unfortunately, students/trainees often receive less corrective feedback than is needed.<sup>5,6</sup>

Timely and standardized feedback is helpful in self-directed learning.<sup>7</sup> Therefore, students are expected to receive timely feedback from their instructors regarding personal performance. However, medical school and hospital trainers can be hindered in providing feedback due to their busy schedule and heavy workload.<sup>8</sup> As a result, medical students do not always receive an adequate level of trainer feedback.

For this reason, the author developed an auto-

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mated, personalized, real-time feedback system based on the Modular Object-oriented Dynamic Learning Environment (Moodle) platform and evaluated the system by analyzing the performances and survey responses of third- and fourth-year medical students.

## MATERIALS AND METHODS

### 1. MATERIALS

Third- and fourth-year medical students of Kosin University College of Medicine who had received education regarding blood transfusions by the author during their second year voluntarily agreed to participate in this study. Fourth-year students received education on transfusion once more during the clinical component of their education. All of the processes in this study were voluntarily performed by the students, who were informed in advance that their grades on the quizzes in this study would not be included in their final class grade.

### 2. METHODS

Participants were instructed to login to the website developed by the author and to complete the courses presented on the website (Fig. 1). The sequentially completed courses consisting of a survey that evaluated their prior knowledge, quizzes for testing the learning objectives, the feedback, a final exam, and a survey evaluating the usefulness of and satisfaction with the automated, re-

al-time feedback system. All of the courses on the website were created using Moodle version 2.2 software. In the first survey, which probed the participants' prior knowledge of blood transfusions, students were queried concerning their present knowledge about transfusions with regard to 17 separate learning objectives (Appendix 1). Responses were given on a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The quiz questions reflected the 17 learning objectives and were sequentially presented (Fig. 1A, 1B). Once the questions that assessed the first learning objective were answered, the next questions that assessed the second learning objective were shown on the screen, and so on. When the scores on the quizzes were not greater than the criteria set by the author for each learning objective, relevant feedback was displayed on the screen (Fig. 1C, 1D). The feedback was designed to support self-directed learning. As a result, any students who failed to obtain higher scores than the criteria received feedback on all learning objectives they had failed. Students who obtained a score greater than the cutoff for all learning objectives did not receive feedback. The feedback was presented when the students completed the quizzes for each learning objective. If all quizzes were not completed in a session, only feedback on the completed quizzes was provided. Feedback was presented immediately after quiz completion and was created with a function named "web page" on the Moodle platform. The feedback offered learning resources, information,

1A [Quiz]

하나의 퀴즈가 완료되면 자동으로 다음에 풀 퀴즈가 활성화됩니다. 모두 17개의 퀴즈를 완료하면 됩니다. 퀴즈에 답한 후 **모두 제출하고 끝냄** 을 누른 뒤 오른쪽 상단에 **검토마침** 을 누른 후 상단의 **임상실습(의약4)-진단검사의학과(2012-01)** 의 네비게이션 메뉴를 누르십시오.

→ 4:2X 0:00

- 1. 나는 전혈(Whole blood)과 농축적혈구(Red blood cells: RBC)를 어떤 경우에 각각 사용하는지 구별하여 사용할 수 있다. → 4:2X 0:00
  - 2. 나는 세척적혈구(Washed RBC)를 사용해야 하는 경우를 알고있다. → 4:2X 0:00
- 활동 조건 제한: '1. 나는 전혈(Whole blood)과 농축적혈구(Red blood cells: RBC)를 어떤 경우에 각각 사용하는지 구별하여 사용할 수 있다'에서 요구된 최소 점수를 얻을 때까지 이용할 수 없음'
- 3. 농축혈수판과 성분채집혈수판의 차이에 의한 임상적 의의를 설명할 수 있다. → 4:2X 0:00
- 활동 조건 제한: '2. 나는 세척적혈구(Washed RBC)를 사용해야 하는 경우를 알고있다.에서 요구된 최소 점수를 얻을 때까지 이용할 수 없음'
- 4. 나는 혈소판제제(Platelet concentrate)와 성분채집혈소판(Plateletpheresis)을 구별하여 적절히 사용할 수 있다. → 4:2X 0:00
- 활동 조건 제한: '3. 농축혈수판과 성분채집혈수판의 차이에 의한 임상적 의의를 설명할 수 있다.에서 요구된 최소 점수를 얻을 때까지 이용할 수 없음'

1B

다음에 열거된 내용에 해당하는 것을 서로 짝지어라.

산소 운반능만을 보강하기 위해서는 이 제제가 더 좋다.

총 25% 이상의 출혈이 있을 때 사용한다.

농축적혈구를 1unit 수혈하면 Hb이 dL당 몇 g 오를 것을 기대하는가?

(답란에는 숫자만 적으시오.)

답:

1C [Feedback]

위 퀴즈를 완료하면 자동으로 필요한 피드백이 활성화됩니다. 활성화된 피드백은 퀴즈의 내용을 100% 맞지 못했을 경우 나타납니다. 따라서 다시 한번 피드백 내용을 읽어 보고 자신이 잘 몰랐던 부분을 공부하시기 바랍니다.

→ 4:2X 0:00

- 1. 나는 전혈(Whole blood)과 농축적혈구(Red blood cells: RBC)를 어떤 경우에 각각 사용하는지 구별하여 사용할 수 있다. → 4:2X 0:00
- 활동 조건 제한: '1. 나는 전혈(Whole blood)과 농축적혈구(Red blood cells: RBC)를 어떤 경우에 각각 사용하는지 구별하여 사용할 수 있다'에서 일정 범위의 점수를 얻지 못하는 한, 이용할 수 없음'
- 2. 나는 세척적혈구(Washed RBC)를 사용해야 하는 경우를 알고있다. → 4:2X 0:00
- 활동 조건 제한: '2. 나는 세척적혈구(Washed RBC)를 사용해야 하는 경우를 알고있다.에서 일정 범위의 점수를 얻지 못하는 한, 이용할 수 없음'
- 3. 농축혈수판과 성분채집혈수판의 차이에 의한 임상적 의의를 설명할 수 있다. → 4:2X 0:00
- 활동 조건 제한: '3. 농축혈수판과 성분채집혈수판의 차이에 의한 임상적 의의를 설명할 수 있다.에서 일정 범위의 점수를 얻지 못하는 한, 이용할 수 없음'
- 4. 나는 혈소판제제(Platelet concentrate)와 성분채집혈소판(Plateletpheresis)을 구별하여 적절히 사용할 수 있다. → 4:2X 0:00
- 활동 조건 제한: '4. 나는 혈소판제제(Platelet concentrate)와 성분채집혈소판(Plateletpheresis)을 구별하여 적절히 사용할 수 있다.에서 일정 범위의 점수를 얻지 못하는 한, 이용할 수 없음'

1D 1. 나는 전혈(Whole blood)과 농축적혈구(Red blood cells: RBC)를 어떤 경우에 각각 사용하는지 구별하여 사용할 수 있다

전혈과 농축적혈구를 구별하여 사용할 수 있어야 합니다. 우선 전혈은 환자가 25%이상의 출혈을 하였을 경우 hypovolemic shock이 유발될 위험이 있는 경우 산소운반능을 보강하고 체액량을 보충하기 위해서 사용하는 것입니다. 그러나 대량 출혈은 없고 단지 혈색소 수치만 기준 이하로 떨어져 있어 산소운반능에 따른 무작용이 예상되는 경우는 적혈구만 보충하여 주면 됩니다. 즉, 농축적혈구만을 수혈합니다.

혈액은 여러가지 성분들로 복합물로서 환자에게 필요하지 않은 성분들도 많이 포함하고 있으며 적혈구만 필요한 환자에게 불필요한 혈장과 단백질을 공급할 필요는 없으며 이것도 결국은 남의 장기를 이식하는 효과를 주기때문에 이로인한 불필요한 면역작용을 유발하여 향후 환자에게 위험한 항HLA 항체 등이 만들어질 수 있습니다.

또한 혈액 내에는 한혈자로 부터 전파된 유행성 감염을 유발할 수 있는 다양한 병원체가 포함될 수 있습니다. 대표적인 것이 간염과 HIV 입니다.

따라서 수혈은 꼭 필요한 성분만 주는 것이 원칙입니다.

적혈구 수혈이 필요한 Hb 값은 얼마인지 찾아보고 이 설정값보다 높아도 수혈을 해야하는 경우가 어떤 경우가 있는지 찾아 보시기 바랍니다.

1E 퀴즈 찾아가기

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시도 종료 ...

질문 1

아직 답하지 않음

Marked out of 1.00

질문에 표시

질문 편집

혈소판수혈불응증을 예방하기 위해 적절한 방법을 모색해야 한다. 다음에 나열된 내용을 바르게 연결하라.

혈소판과 함께 수혈된 백혈구에 의해 환자의 몸에 새로운 항HLA 항체가 생성되고 이것에 의해 새로 투여되는 혈소판이 파괴되는 것을 미연에 방지하기 위해서는 혈액 제제 투여 시 함께 들어가는 백혈구를 제거해야 한다. 이것을 위해 흔히 임상에서 사용되는 것이다.

항HLA 항체의 종류를 줄이기 위해서는 공혈자의 수를 줄이는 것이 효과적이다. 이러한 목적에서는 한번에 6개 이상을 투여하는 농축혈소판과 한 명의 공혈자에서 충분한 양의 혈소판을 채집하여 만든 성분채집혈소판 중 어느 것이 유리하나?

Fig. 1. The quiz, feedback, and final exam provided to the students in this study. The quiz, feedback, and final exam were hosted on the website, which was developed by the author on the Moodle platform. When students clicked on the quiz question number (A), the quiz question appeared on the screen (B). After completing the quizzes, the students could view feedback that varied depending on quiz score (C), view the activated feedback, and perform self-directed learning guided by the feedback (D). After completion of the self-directed learning, students were permitted to take the final exam.

and comments associated with the learning objective. The author expected the feedback to help the students participate in self-directed learning. After the feedback step, the students were instructed to complete a second presentation of the quiz questions that reflected the same 17 learning objectives, which was intended to consolidate their learning (Fig. 1E). After completion of the final exam, the students were asked to complete a survey on the degree of satisfaction with and usefulness of the automated, real-time feedback system (Appendix. 2). This survey used a function named “restrict access” on the Moodle platform. The author set the minimum grade required on the quizzes for each learning objective, and the feedback was activated and presented when the requirements were not satisfied.

### 3. Surveys and statistical analyses

The surveys that assessed the students’ prior knowledge consisted of 17 questions, while the surveys focusing on degree of satisfaction with and usefulness of the automated, real-time feedback system consisted of six and seven questions, respectively. Responses to all questions used a five-point Likert-type scale from 1 (least agree) to 5 (most agree), and the reliability of the test score was calculated using Cronbach’s  $\alpha$  statistics. Subjective opinions from the students regarding the merits and drawbacks of the automated, real-time feedback system in this study were also requested (Appendix 2).

To analyze the statistical differences in partic-

ipant prior knowledge, the final exam, degree of satisfaction with and usefulness of an automated real-time feedback system between the third- and fourth-year medical students, independent t-test was performed. All statistical analyses were conducting using the Statistical Package for the Social Sciences (SPSS) version 17.0 (SPSS, Chicago, IL, US).  $P$ -values  $< 0.05$  were considered statistically significant.

## RESULTS

The number of third- and fourth-year medical students who participated was 66 and 65, respectively. Forty students from each class completed all courses for this study (60.61% of third-year and 61.54% of fourth-year students).

### 1. Survey for prior knowledge

All 17 questions were asked, and the reliability according to the Cronbach’s  $\alpha$  was 0.949. The rating mean (standard deviation, SD) of the third- and fourth-year students was 3.35 (0.85) and 3.82 (0.67), respectively; the fourth-year  $P$ -values were significantly higher than those of the third-year students ( $P = 0.008$ ) (Table 1).

### 2. Quiz

The quiz scores (SD) of the third- and fourth-year medical students were 85.57 (10.26) and 89.66 (7.51) out of 100, respectively, with the fourth-year student score being significantly high-

**Table 1. Mean, standard deviation (SD), and t-test results of third- and fourth-year medical students on a survey of prior knowledge, usefulness, and satisfaction conducted using Moodle**

Test items	Grade	N	Mean	SD	P
Survey of prior knowledge	3	40	3.35	0.85	0.008
	4	40	3.82	0.67	
Usefulness survey	3	40	4.55	0.46	0.190
	4	40	4.40	0.58	
Survey of satisfaction	3	40	4.45	0.64	0.480
	4	40	4.34	0.67	

N, number; SD, standard deviation; P, p-value in t-test

**Table 2. Scores between third-year and fourth-year medical students**

Category	Mean (SD)		T-test
	Third year (n=40)	Fourth year (n=40)	
Quiz	85.57 (10.26)	89.66 (7.51)	<i>P</i> = 0.046
Final quiz	96.02 (4.56)	95.53 (4.74)	<i>P</i> = 0.633

SD, standard deviation

er (*P* = 0.046) (Table 2).

### 3. Final exam

The quiz scores (SD) of the third- and fourth-year medical students were 96.02 (4.56) and 95.53 (4.74) out of 100, respectively. There was no significant difference between the two groups (*P* = 0.633) (Table 2).

### 4. Degree of satisfaction with the automated, real-time feedback system

Six questions were asked regarding satisfaction, and the reliability based upon Cronbach’s  $\alpha$  was 0.913 (*P* = 0.00). The rating mean (SD) of the third- and fourth-year medical students was 4.45 (0.64) and 4.34 (0.67), respectively. There was no sig-

nificant difference between the two groups (*P* = 0.480) (Table 1, 3).

### 5. Usefulness of the automated, real-time feedback system

Seven questions regarding usefulness were asked, and the reliability according to Cronbach’s  $\alpha$  was 0.857 (*P* = 0.00). The rating mean (SD) scores of the third- and fourth-year students were 4.55 (0.46) and 4.40 (0.58), respectively. There was no significant difference between the two groups (*P* = 0.190) (Table 1, 3).

### 6. Subjective opinions about the merits and drawbacks of the automated, real-time feedback system

**Table 3. The degrees of satisfaction with and usefulness of a computer-assisted, automated, real-time feedback system amongst medical students**

Category	Questions	Min	Max	M	SD
Degree of Satisfaction	I was pleased with the Blood Transfusion class.	1	5	4.29	0.81
	Quizzes used in the Blood Transfusion class were helpful for learning about blood transfusions.	2	5	4.55	0.61
	The feedback used in the Blood Transfusion class was helpful for studying blood transfusions.	3	5	4.46	0.64
	It was easy to follow the feedback presented.	2	5	4.31	0.88
	The content of the quizzes and the feedback were related to what is necessary for studying blood transfusions.	2	5	4.41	0.79
	As a whole, I am satisfied with this Blood Transfusion class that was supported by a computer-assisted feedback system.	1	5	4.34	0.91
Usefulness	The quizzes provided on the homepage were helpful for learning about blood transfusions.	3	5	4.58	0.61
	The content of the quizzes was related to what was taught during the Blood Transfusion class.	3	5	4.70	0.54
	The content of the feedback adequately pointed out what I need to know.	3	5	4.36	0.66
	The content of the feedback was helpful to me when I took the final exam.	2	5	4.40	0.74
	The spontaneous feedback after the quiz was helpful.	2	5	4.58	0.69
	It was easy to read and comprehend the feedback.	1	5	4.34	0.86
	The computer-assisted feedback system was helpful for studying about blood transfusions.	1	5	4.39	0.83

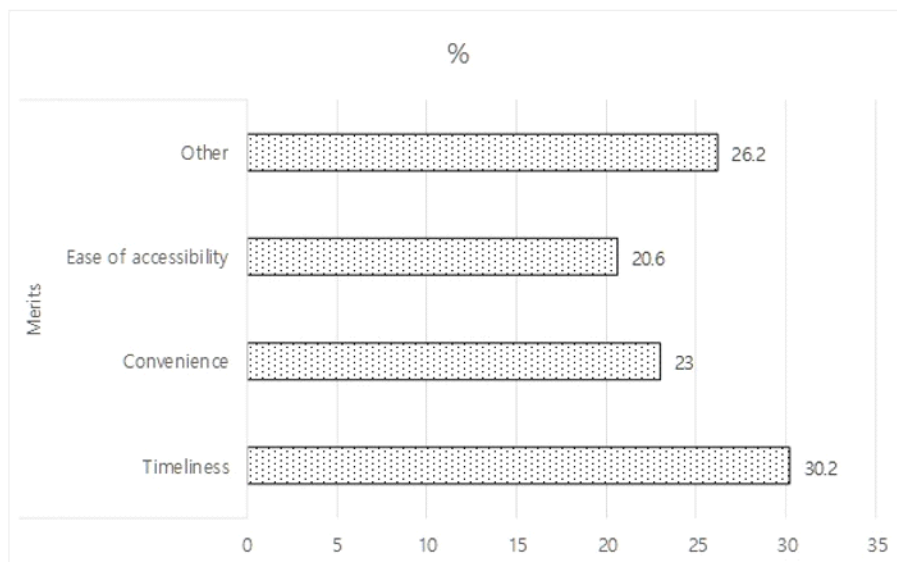
Min, minimum; Max, maximum; M, mean; SD, standard deviation.

Timeliness (30.2%), convenience (23.0%), and ease of accessibility (20.6%) were the highest ranked subjective opinions from students (Fig. 2A). The most frequently mentioned drawback was technical problems relating to internet speed or low computer specifications (47.0%), followed by difficulty in communication (16.6%) and poor readability (13.1%) (Fig. 2B).

## DISCUSSION

E-learning is already popular in medical education and is well established in many medical schools.<sup>9</sup> An e-learning consortium was established in Korea in January 2007 with the goal of developing and sharing e-learning content among medical students.<sup>10</sup> Thirty-three of the Korea's 41 medical schools participate in this consortium (<http://www.mededu.or.kr>). Most medical stu-

2A



2B

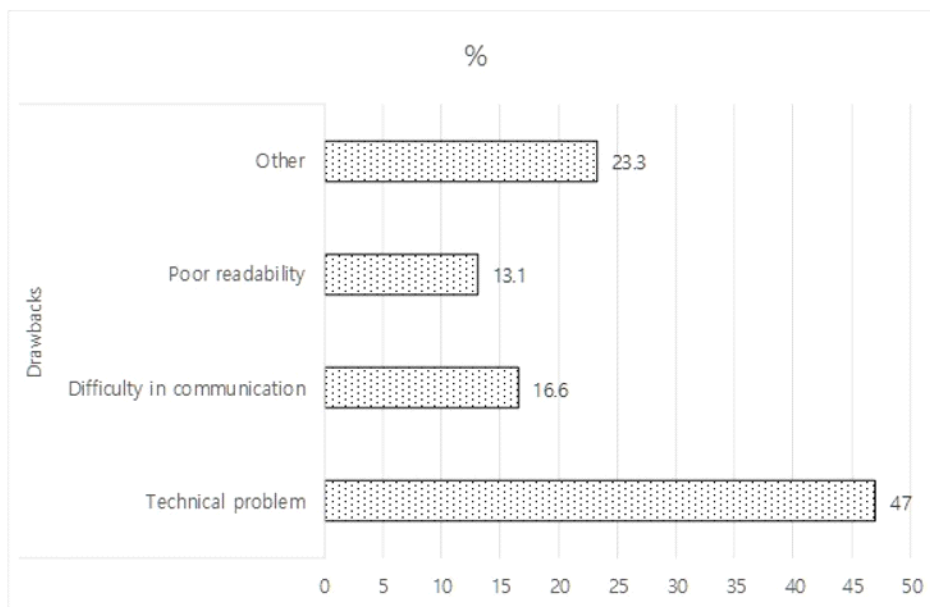


Fig. 2. Subjective opinions from students about the merits and drawbacks of the automated, real-time feedback system. Some highly ranked opinions are listed, and more opinions are included in the “Other” category.

dents are accustomed to accessing the e-learning resources using their smartphone or tablet, regardless of time or place.

These internet-based technologies are gradually broadening their educational applications, and students are using the technologies for learning.<sup>11-16</sup>

Moodle has been continuously evolving as an open-source environment since it was first developed for web-based learning in 1998; it has been applied to medical education in some instances.<sup>17,18</sup>

The automated, real-time feedback system in this study was developed on the Moodle platform;

the “restrict access” function of Moodle makes it possible for education providers to set the criteria for the grade or activity of the learning, which facilitates an individualized learning environment for students. This means that reaction to activities can differ depending on the responses from students, which is a very powerful tool for individualized, self-directed learning.

Students who participated in this study also received different feedback depending on the grade obtained on the quiz. Students who showed good academic performance could save time, which is helpful for efficient academic activity. Delivering feedback is a complex process influenced by many factors.<sup>19</sup> More sophisticated modules could be created as the need arises, which is a merit of Moodle.

When the students’ prior knowledge was evaluated, the mean rating of the fourth-year students was significantly higher than that of the third-year students. This difference was expected since the fourth-year students had been educated on the subject in class as well as in the clinic. On the final exam, however, there was no statistically significant difference between the two groups. Instead, the students seemed to study what they needed to learn using the presented feedback, which could have improved their learning and decreased the difference in quiz scores between the two groups. The automated, real-time feedback system also might have helped standardize learning for the students with lower grades by increas-

ing their self-directed learning.

Although the most frequently mentioned drawback of the program was technical problems according to the subjective opinions from students, another important limitation was that students could not ask any additional questions if their academic concern had not been addressed. Sisson et al. insisted that incorporating learner feedback into curriculum revision was associated with improved educational outcomes.<sup>20</sup> To resolve this problem, devices or applications that let students ask additional questions should be included in the curriculum. For this purpose, a social network service or the Moodle “forum” function could be used for communication between students and trainers. Regardless of this drawback, students were very satisfied with the timeliness, convenience, and ease of accessibility with which they could study what they needed at any time and place.

Considering the busy routines of medical education providers, medical students often do not receive adequate feedback from their trainers. The automated, real-time feedback system used in this study could be a very useful tool for effective and standardized feedback. Although an additional device would be required to handle any questions from students, it is thought that this automated, personalized, real-time feedback system provided timely effective feedback for the students and was helpful for their self-directed learning.



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**Appendix 1. Questions for probing the participants' prior knowledge of blood transfusions with the automated, real-time feedback system**

**사전 지식 점검 설문**

\*1

나는 전혈(Whole blood)와 농축적혈구(Red blood cells: RBC)를 어떤 경우에 각각 사용하는지 구별하여 사용할 수 있다. 즉, 이런 경우는 전혈을 사용하고 이런 경우는 농축적혈구를 사용한다는 식으로 사용 기준을 알고 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*2

나는 세척적혈구(Washed RBC)를 사용해야 하는 경우를 알고 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*3

나는 혈소판제제(Platelet concentrate)와 성분채집혈소판(Plateletpheresis)을 구별하여 적절히 사용할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*4

혈소판불응증을 방지하기 위한 방법을 취할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*5

수혈에 의한 이식편대숙주병(GVHD)가 무엇인지 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*6

수혈에 의한 이식편대숙주병(GVHD)를 예방하기 위해 혈액제제에 취해야 하는 방법을 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*7

가족 간의 수혈에서 혈액제제에 감염을 조사해야 하는 이유를 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*8

신선동결혈장(Fresh Frozen Plasma: FFP)을 언제 사용해야 하는지 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*9

동결침전제제(Cryoprecipitate)를 언제 사용하는지 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*10

치료적 혈장교환 (Therapeutic plasma exchange)을 해야 하는 경우를 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*11

농축적혈구를 수액제제와 함께 같은 루터로 환자에게 투여하는 경우 발생할 수 있는 문제를 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*12

수혈로 인한 급성 폐손상을 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*13

농축적혈구 투여 시 적절한 크기의 바늘을 선택하여 사용할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*14

대량수혈 후 Hemosiderosis를 예방하기 위해 필요한 조치를 취할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*15

수혈로 전파되는 감염 질환을 5가지 이상 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*16

수혈전감사에서 수혈전파성 감염을 예방하기 위해 현혈된 혈액을 이용하여 안전성을 확보하기 위해 여러가지 검사들이 행해진다. 이때 통상적으로 행해지는 일부 바이러스성 감염에 대한 검사에서 window period로 인해 야기되는 문제점을 설명할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\*17

농축적혈구를 수혈해야 할지 말지를 정확한 근거로 판단할 수 있다.

Almost Never	Seldom	Sometimes	Often	Almost Always
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Appendix 2. Questions for evaluating the usefulness of and satisfaction with the automated, real-time feedback system**

컴퓨터를 활용한 자동 피드백 시스템의 유용성에 관한 설문	학습 만족도 설문																				
<p>*1 홈페이지에 게시된 퀴즈는 혈액은행 학습에 도움이 되었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*8 나는 혈액은행 학습이 즐거웠다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>*2 퀴즈 문항들은 혈액은행 시간에 배운 내용들과 관련이 있었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*9 혈액은행 학습에 사용된 퀴즈는 학습에 도움이 되었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>*3 피드백 내용은 내가 모르는 부분을 잘 지적하였다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*10 혈액은행 학습에 사용된 피드백은 학습에 도움이 되었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>*4 최종 평가 문제를 풀 때 피드백 내용이 도움이 되었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*11 컴퓨터 상의 피드백이 이해하기 쉬웠다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>*5 퀴즈를 풀고 피드백을 바로 받을 수 있어서 도움이 되었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*12 컴퓨터를 활용한 퀴즈와 피드백 시스템은 필요한 내용을 적절히 잘 다루고 있다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>*6 피드백 내용을 읽고 이해하는데 어려움이 없었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*13 나는 전체적으로 컴퓨터를 활용한 자동 피드백 시스템을 사용한 혈액 은행 수업에 만족한다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>*7 컴퓨터를 활용한 피드백 시스템이 혈액은행 학습에 도움이 되었다.</p> <table border="1"> <tr> <td>Almost Never</td> <td>Seldom</td> <td>Sometimes</td> <td>Often</td> <td>Almost Always</td> </tr> <tr> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </table>	Almost Never	Seldom	Sometimes	Often	Almost Always	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<p>*14 컴퓨터를 활용한 자동 피드백 시스템 수업의 장점을 말한다면?</p> <div style="border: 1px solid black; height: 40px; width: 100%;"></div>										
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	<p>*15 컴퓨터를 활용한 자동 피드백 시스템의 단점을 말한다면?</p> <div style="border: 1px solid black; height: 40px; width: 100%;"></div>																				
	<p>*16 컴퓨터를 활용한 자동 피드백 학습에서 개선점이나 필요한 것을 말씀해 주세요.</p> <div style="border: 1px solid black; height: 40px; width: 100%;"></div>																				

Question numbers 1–7 and 8–13 were used to evaluate the usefulness of and satisfaction with the automated, real-time feedback system, respectively. Three additional questions (numbers 14–16) were included to obtain the students’ opinions about the merits, drawbacks, and requirements of the system.