How to Improve Learning Achievement of Medical Students Regarding Interpretation of Hematology Slides.

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Abstract:

Background: It is essential that Thai medical students learn how to interpret abnormalities of red blood cells, white blood cells and platelets from peripheral blood smears. Following this they need collate this information and make a correct diagnosis of the common hematologic diseases found in Thailand. Because of time constraints, high student to teacher ratios, there being relatively few hematology and clinical pathology specialty clinical teachers, there is a particular need to trial various teaching methods, in order to improve learning outcomes, in relation to the ability of the students to correctly interpret hematology slides.

Objective: The author would like to know the efficiency of different learning methods by using an immediate answer feedback following each quiz of peripheral blood hematology slides. With this method, the author would like to measure the progress of the medical students by comparing scores from the tests.

Methods: Before learning, the medical teacher gave the third year medical students a paper on how to interpret a peripheral blood smear, for self-study. To promote active learning, 2 days after self-study, the medical teacher presented the first session, called **demonstration slides** (14 diseases or conditions) as seen using a light microscope. This was conducted in an OSCE-examination style, 5 minutes per station, in order to ensure that all students examined the slides during the session. There was no formal marking of this session. Immediately after the demonstration test, the teacher gave the answers and pictures from the light microscope online to all students, via Google classroom. In the afternoon of the same day, the teacher conducted a second **quiz,** with slides of 14 different diseases and collected the scores from each student. Again, following completion the answers were revealed. The students were then able to check their results via Google classroom or LINE social media. One week later, at the time of **final examination,** slides of 23 diseases (some diseases were repeated but different questions or from different patients) were presented, the teacher then compared the scores from this last test to the second test and the answer was again sent to all students via the same channels. One way ANOVA test was used for

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analyzing mean differences between tests with p-value < 0.05 at 95% confidential interval (CI) was considered to be significant.

Results: There were 32 medical students in the class. Thirty of 32 students (93.8%) showed improved scores from the first to the second test. Thirty of 32 students (93.8%) had improvement from the second test to the final examination. Mean points ± S.D. scores from the first test were 2.33 ± 0.97 compared to 4.33 ± 0.97 in the second test and 6.07 ± 0.81 in the final examination. All 32 students achieved significantly improved scores ($p<0.001$) from the first to the final test, confirming increased learning achievement.

Conclusion: The examination-based teaching was shown to be an effective way to improve the learning of hematology slides. This teaching concept was stimulating, consumed less time, was cost-effective, had no requirement for high technology equipment and the students were able to learn about many diseases at the same time. The immediate feedback of answers, linked to pictures from the light microscope, was a key factor leading to this success. However, the retention of knowledge needs either repetitive examination or promotion of active learning, by consistent self-study, depending on the needs of different individuals.

Keywords: Hematology slides, Teaching, Examination, Learning achievement

Introduction

Hematology and the lymphoreticular system are one of compulsory subjects for preclinical-year and clinical-year medical students in Thailand. Hematology slides teaching is one part of the topics in this subject at School of Medicine, Mae Fah Luang University, Chiang Rai, Thailand, as well as most medical schools in Thailand. There are many hematologic diseases in Thailand. The benefits of peripheral blood smear (PBS) inspection are to make an accurate diagnosis of many hematologic diseases quickly, especially with basic clinical data such as history, physical examination and complete blood count (CBC). It does not require high technology, simply a light microscope and can be carried out at any time. So, inspection of PBS is very cost-effective. Many medical teachers, especially in hematology or clinical pathology, have come to realize the advantages of teaching using hematology slides, and stress to the medical students the importance of studying PBS, in order to become familiarized with abnormalities of red cells, white cells and platelets. In many medical schools, teaching this subject in both pre-clinical and clinical years, is conducted, in order to increase the experience of medical students who, following graduation, could be working in rural hospitals, with restricted resources.

The problems of teaching hematology slides relate to the restricted numbers of medical teachers compared to the number of students, time constraints and occasionally the lack of materials for teaching, such as typical slides of specific diseases. The usual method of teaching is to give each student a slide box of specific hematologic diseases and instruct the student to self-study and to ask the teacher whenever they have any questions. This method does not work effectively for many reasons. The medical students have not enough time to self-study. Some students are careless and break the slides unintentionally or loose slides for unknown reasons. There are also some students who never study the slides, a waste of time and teaching resource.

In order to make teaching hematology slides more effective and increase the concentration of students, teaching by examination is another way to increase student participation and follow the progress of learning achievement. Teaching by examination is used in many schools and universities. This style of teaching stimulates student participation. It does create some stress which normally results in increased concentration on the subject by the students. Measurement of teaching by examination may be performed using various tests, such as MCQ (multiple choice question) test, short answer or lab/OSCE (Objective Structured Clinical Examination)[1] tests. OSCE gives a limited time for the student to understand the question and the students then produce their answer in a similar short period of time. The OSCE is a feasible approach to the assessment of clinical competence for use in different cultural and geographical contexts; to assess a wide range of learning outcomes; in different specialties and disciplines; for formative and summative purposes; to assess students curriculum or an educational intervention; in the different phases of education, including the early and later years of the undergraduate curriculum; and in different health care professional settings.[2]

Method

The study was prospectively done in preclinical third year medical students, attending Mae Fah Luang University, during the Hematology and Reticular system block, in the second trimester of the 2020 academic year, taught during 11-22 January 2021. This block consisted of lectures, case discussions, case demonstrations and hematology slides. The author used examination based studies only in the hematology slides, to study this concept relating to learning achievement, after completion of the block. The study started on the fourth day of the block when the students had learned some topics during the first three days. The author uploaded all learning topics on Google classroom, in pdf format, including "How to interpret a peripheral blood smear" ahead of the actual class. In the morning of the fourth day, the author conducted the first demonstration test, which consisted of 14 PBS slides of various common hematologic diseases encountered in Thailand. The test was performed in rotating stations, 5 minutes for each station. Immediately after finishing the test, the answer was posted in Google classroom. The test score of each slide was 100, grading of the scores was 30 for the diagnosis and 70 for the explanation. The scores from the first test were evaluated and weighted 10% but not collected. After the students had marked themselves using the teacher's answers, the second test was performed in the same style, with different or the same diseases, but using different patient details, and the scores were again collected and weighted as 10% of the final total. Again, the answers were uploaded after completion of the test. So, the students had time to evaluate themselves and they could ask the teacher in detail via LINE or Google classroom. One week later, on the last day of the block, the third test was carried out with 23 PBS slides stations and the scores were weighted 10%. The teacher also uploaded the answers after the examination. The first author was the only one who examined and evaluated the answers of 32 students in all three tests.

The first test called demo consisted of 14 slides of diseases or conditions: thalassemia, viral infection (dengue fever), pancytopenia, chronic lymphocytic leukemia, essential thrombocythemia, leukemoid reaction, chronic myeloid leukemia, primary myelofibrosis, polycythemia vera, acute lymphoblastic leukemia, acute myelomonoblastic leukemia, acute promyelocytic leukemia, acute monoblastic leukemia and multiple myeloma.

The second test called quiz consisted of 14 slides of diseases or conditions: primary myelofibrosis, immune thrombocytopenia, polycythemia vera, drug-induced secondary thrombocytosis, marked eosinophilia, thalassemia, iron deficiency anemia, multiple myeloma, thrombotic thrombocytopenic purpura, G6PD deficiency with acute hemolysis, hereditary spherocytosis, autoimmune hemolytic anemia, beta thalassemia with post splenectomy.

The third test and final test consisted of 23 slides of diseases or conditions: hereditary elliptocytosis, G6PD deficiency with acute hemolysis, thalassemia, homozygous Hb E, essential thrombocythemia, chronic myeloid leukemia, immune thrombocytopenia, chronic lymphocytic leukemia, polycythemia vera, acute myeloid leukemia, lymphoplasmacytoid lymphoma, iron deficiency anemia, Hb H disease, autoimmune hemolytic anemia-cold type, lymphoma in blood smear, primary myelofibrosis, hereditary spherocytosis, acute lymphoblastic leukemia, acute promyelocytic leukemia, thalassemia trait, thrombotic thrombocytopenic purpura, viral infection (dengue hemorrhagic fever) and pancytopenia. A sample of the test is shown in Figure 1.

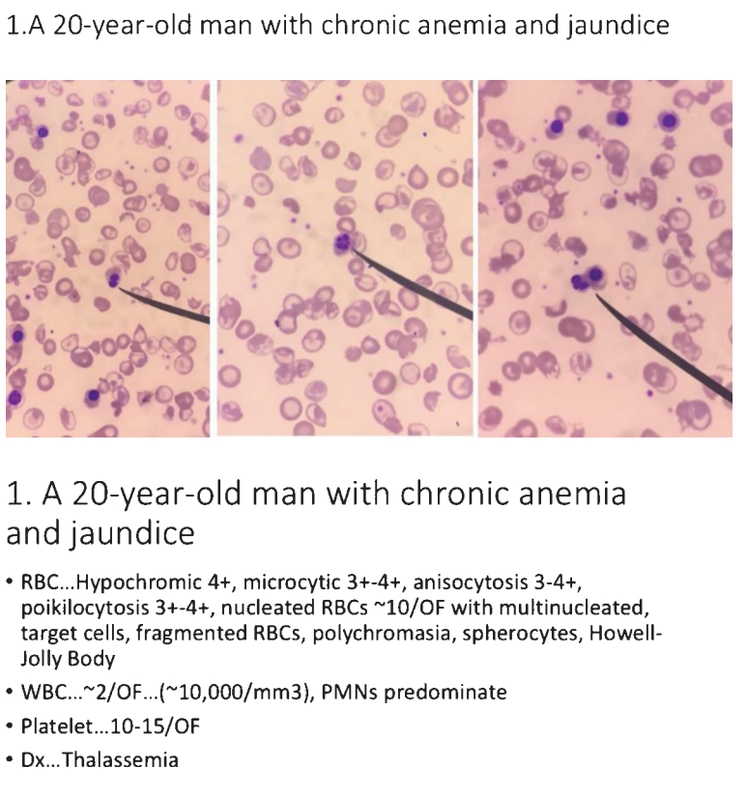


Figure 1 Sample of the test with picture and a key of the answers

Statistical analyses were conducted with the IBM SPSS Statistics 26.0 program (Armonk, New York, USA). To evaluate learning achievement of the students after each test, the scores were calculated in mean ± S.D. and plotted in graphic form. One-way ANOVA was used for comparing overall mean differences between the three tests. Post-Hoc test was used to compare mean scores differences between 1st and 2nd test, 2nd and 3rd test and finally 1st and 3rd test. Statistical significance was considered when p-value was ≤ 0.050 at 95 % confidential interval (CI).

Result

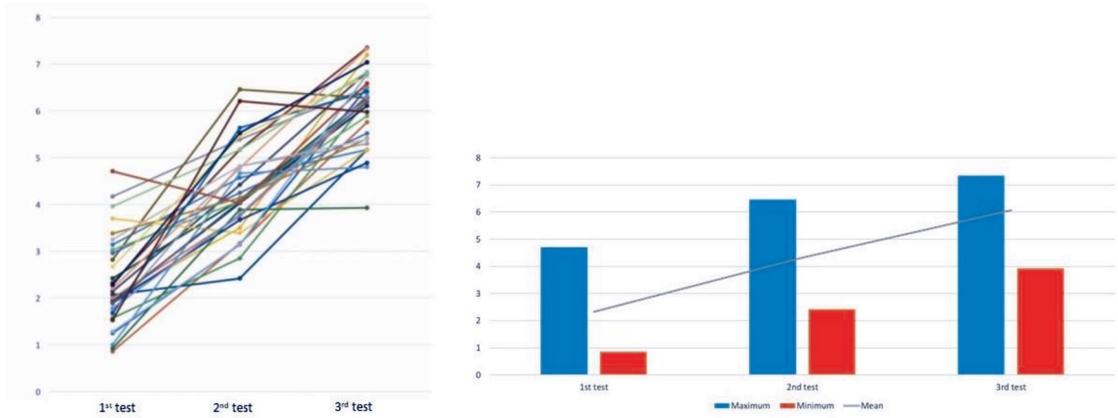
There were 32 medical students in this class, two students were retaking the year. All students completed the block and had taken the examination. The examination was weighted 60% for MCQ, hematology slides 20% (10% each for the second and the final test), case discussion 10% and attending the class 10%. For the convenience of comparison, the author calculated 10% in each test as being equal to 10 points and used this measure for statistical comparison. Thirty of 32 students (93.8%) showed improvement in their scores from the first to the second test. Thirty of 32 students (93.8%) improved their scores from the second test to the final examination. All students showed improved learning achievement from the first to the final examination, as shown in Figure 2

Mean scores and S.D.

Mean scores ± S.D. of the students from the first test (demo) was 2.33 ± 0.97 compared to 4.33 ± 0.97 in the second test (quiz) and 6.07 ± 0.81 in the final examination. The point score of each student was plotted and is shown in Figure 2. The results of mean scores and S.D. are displayed in Table 1. Minimum scores of 1st, 2nd and 3rd tests were 0.86, 2.42 and 3.93, respectively. Maximum scores of 1st, 2nd and 3rd tests were 4.71, 6.46 and 7.35, respectively.

Comparison between tests

One-way ANOVA showed that there was a significant overall difference in students' point score between the three tests ($p < 0.001$). Using Levene statistics, p-value was 0.578, indicating assumed equal variance. The Bonferroni test was used for Post-Hoc comparison, and demonstrated significant differences between the mean scores of the first and the second test (means difference 2.00, $p < 0.001$, 95 % CI 1.44 – 2.56), the second and final test (means difference 1.74, $p < 0.001$, 95 % CI 1.18 – 2.30) and the first and the final test (means difference 3.74, $p < 0.001$, 95 % CI 3.18 – 4.30). The results were shown in Table 1.



A B

Figure 2 Progression of learning achievement in 32 medical students after each test: A; all 32 students, B; maximum (blue), minimum (orange) and mean score (line) of each test

Table 1 Comparison between points of three hematology slide tests

Mean ± S.D.			One-way ANOVA				Mean points difference comparisons	p-value
1st test	2nd test	3rd test	Levene statistics	p-value of test of homogeneity of variances	F	p-value of One-way ANOVA		
2.33 ± 0.97	4.33 ± 0.97	6.07 ± 0.81	0.551	0.578	132.65	< 0.001*	2nd test > 1st test	< 0.001*
							3rd test > 2nd test	< 0.001*
							3rd test > 1st test	< 0.001*

* Significant at 95 % CI

Discussion

The study was pre-planned and prospective to evaluate the efficacy of examination-type teaching in hematology slide interpretation and initial diagnosis. In Thailand, there are some medical schools, for example Chiang Mai University in northern Thailand, using OSCE with demonstrated constructive feedback, achieving impressive results, proving that this concept is not only a good assessment tool but also is an effective teaching method in blood smear interpretative skills[3]. Another study from the Medical Education Center of Buriram Hospital in northeastern Thailand, showed that formative evaluation had enhanced the clinical skills of blood smear interpretation in medical students[4]. Initially, the author wished the students to be able to interpret abnormalities of red blood cells, white blood cells and platelets. The medical students were not yet proficient in diagnosis but there were ongoing lectures of hematology disorders later in the course. The author prepared the lecture, on how to interpret blood smear, as a self-study topic. The first test acted as a demonstration, the second test was the quiz, held during the first week of the course. The final test, the third, was held as part of the final examination. All students performed an evaluation of the teaching process after completion of the course. Most students used the key (answer) after each test to self-assess their performance, and improved their learning achievement, following each successive test. All students showed progression of their performance from the first test (mean $\pm$ S.D.) 2.33 ± 0.97 compared to 4.33 ± 0.97 in the second test and 6.07 ± 0.81 to the final test. The main key to success for this study was active learning of the students, examination-style of teaching, feedback after each test by immediately posted answers and then repeated testing. From their evaluation, the students would like to sit a smaller number of final test, because of the time involved, also they felt tired. Following student suggestion, the author plans to improve the learning process to accommodate an improved learning atmosphere in the next year by altering the timing of the test, smaller number of tests, and improved lecture on how to interpret blood smears before the test. However it is clear that retention of knowledge needs repetitive examination and/or ongoing active learning by self-study, depending on individual learning characteristics.

Conclusion

Examination-based teaching has proved to be an interesting and effective method for teaching medical students on how to interpret hematology slides. Ongoing improvement of this learning method,

following student evaluation, can make a better learning and more user friendly environment that will encourage ongoing continuous self-study and retention of knowledge.

Conflict of interest

The authors have declared no conflict of interest

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