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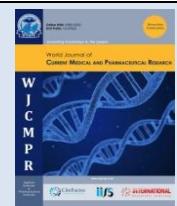
TEAMWORK SIGNIFICANTLY IMPROVES PATHOLOGY SLIDE DIAGNOSIS: STUDENTS' PERSPECTIVE

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Article History	Abstract
	Background & objectives: Team-based learning is a pedagogical strategy that enhances student knowledge through individual testing and group collaboration. The objective of this preliminary study was to examine if students' collaborative annotation improved understanding of microscopic morphology and diagnosis of pathological slides. **Methods:** Mean individual and then group scores of pathology slides analysis by Path2 students were compared by the Wilcoxon signed rank test and group differences by ANOVA. Students' attitudes toward TBL were examined using a short 8-item questionnaire which graded responses on a 5-point Likert scale. Analyses were performed in the SPSS version 20.Probability level of $p<0.05$ was statistically significant. **Results:** The average individual scores ranged from 44.0 to 50.0 out of 100. The differences between the groups were not observed. The average group scores ranged from 75.0 to 82.0percentage. Compared with the average individual score, all group scores were statistically significantly higher ($p<0.001$). Group scores among students who had low performance were statistically significantly higher compared to their individual scores. This was also observed among high performance students ($p<0.003$). In terms of TBL attitudes, all average attitude scores were positive (the highest were reported for active learning). Attitudes score did not correlate with the Path1 grade. No difference in attitudes was found between high and low performing students. **Conclusion:** Group analysis of pathology slides significantly improves the success in making a pathological diagnosis, both for low performance and for high performance students. The strongest positive attitude was observed for "Promotes opportunity for active learning", "Group dynamics potentiate learning outcome" and "Encourage discussion for differential diagnosis". We progressively incorporated these collaborative approaches into virtual environment in pathology courses at our medical faculty that have been shown to further improve students' engagement and learning outcomes, promotes opportunities for active engagement and interaction. *Keywords*: Students' teamwork, Pathology slides, Analysis, Diagnosis, Perception.

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Introduction

Modern and high-quality education of medical students implies integration of theoretical and practical knowledge and stimulation of active learning [1]. There are various methods to achieve this goal, and one of them is teamwork, which has been shown to significantly contribute to student success [2].Team based learning (TBL) is not only applied to the education of medical students, many scientific disciplines around the world have adopted this method in education [3]. In the traditional way of teaching, the lecturer passively transmitted information to the students and this method is not an appropriate scientific strategy and proved to be inferior to the active participation of students where students are taught to apply the learned theoretical knowledge in real situations and clinical scenarios [2, 4]. In teamwork, each student comes to lectures and is focused on the application of the learned content and, collaborating with other group members, discusses the differential diagnosis. This is a significant difference compared to classic lectures where students have much more

communication with the lecturer than with other students due to the method that was applied by passive transfer of knowledge in this method of education [5]. During the Pathology course, medical students are trained to distinguish normal from abnormal microscopic appearance of human tissue (histology and histopathology, respectively). Computer technology makes it possible to use a digitized version of glass slides instead of glass slides with tissue sections [6].This Virtual Microscopy (VM) provides students with the ability to analyze a complete image of a slide throughout the day which enhances student learning [7].This kind of computer-supported collaborative learning (CSLC) enables students to analyze the details of complex issues in which the lecturer has more of a role as a facilitator of knowledge exchange, rather than a dispenser of knowledge [8]. There are published research results that dealt with these issues in large universities [8] with a large number of students.We have already done a survey on the importance of teamwork in the annotation of virtual pathological slides, showing that students scored significantly higher in group as opposed to individual readings(not published results). Our school is an American offshore medical school with a smaller number of students who have a second chance to study medicine and become doctors. In this preliminary study we aimed to assess in our School the effect of team work on diagnosis of pathohistological slides as well as the students' perception of TBL depending on their pathology grades and individual result in establishing a pathohistological diagnosis.

Material and Methods
Participants and Procedure
This study included term 4 students having Clinical Pathology (Path2), Microbiology II, Pharmacology II, Behavior science and Introduction to Clinical and Community Medicine IV, in an offshore American college of medicine (Trinity Medical Sciences University) located on the Caribbean island of St. Vincent and The Grenadines. A total of 36Path2 students participated in this study. At the beginning of term 4 heterogeneous groups of 6 students were created randomly based on their academic performance, gender and ethnicity. In the course of 8 laboratory exercises, students analyzed five digitized slides on each exercise first individually and then as a group, using Aperio Image Scope v12.1.0.5029 software. They had 5 minutes each for individual and team analysis. A pathohistological diagnosis should be given for each slide. At the end of semester, the students were asked to complete an anonymous online survey to assess their perception on group analysis of pathological slides. The students had to answer questions related to the impact of team work on active learning and learning outcome. All the students agreed to participate in the study. Ethical approval for the study was obtained from the Institutional Board of the Trinity Medical Sciences University, GA, USA.

Data collection and analysis
Two different students' cohorts were compared. Participants in this study were divided into two groups based on individual results in the diagnosis of pathohistological slides. Those students who scored 50% or more out of maximum score in 8 laboratory exercises were assigned to the high-performance group. The analysis was also done comparing individual and group results in the diagnosis of pathohistological slides depending on the grade that the students had in General Pathology in the previous semester. Low-performance group with a grade of 75% and lower and High-performance group with a grade higher than 75%. Data were collected by using anonymous questionnaire. The questionnaire was based on the work of Simon [9].and Keen and Packwood [10].The students evaluated how teamwork: Increase interaction between students, Create sense of community, Promotes confidence in applicationof knowledge for problem solving, Promotes opportunity for active learning, Group dynamics potentiate learning outcome, Permits opportunities for leadership development, Helps to integrate concepts taught in classes, and Encourage discussion for differential diagnosis. Answers to each question were graded on a 5-point Likert-type scale: 1-strongly disagree, 2-disagree, 3-not sure, 4-agree, and 5-strongly agree. Data comparisons between groups of students within the same cohort were performed using unpaired t-tests. Comparison of individual and team results within one group was done using pairedt-tests. This test was also used to assess difference between low-performance and high-performance groups. Normality of distribution of students' answers was tested by means of the Kolmogorov-Smimov test. To assess the effect measure for each item (attitude) in the scale relative to grade in pathology, univariante logistic regression was performed. A comparison of the results of the patohistological diagnosis with a pathology score was chosen because the clinical psathology is the most integrative subject in the basic science. The independent variable was attitude for each statement categorized as positive (marked 4 or 5 on Likert scale) or other (marked 1-3 on Likert scale). Probability level of $p<0.05$ was consider significant. The SPSS 17.0 statistical softwer package (SPSS Inc., Chicago, IL, USA) was used in data analysis.

Results
A total of 36 students participated in this research and completed all 8 individual and 8 group lab practical sessions. Individual scores were calculated based on individual achievements in 8 lab practical sessions. The average individual scores ranged from 44.0 to 50.0 out of 100. The differences between the groups tested by ANOVA were not observed. On the other hand, average group scores in 8 lab practical sessions ranged from 75.0 to 82.0. When compared with the average individual score, group scores were statistically significantly higher (Table 01).

Students who scored in lab practical sessions on average above 50% (high-performance students, n=11) had a statistically significantly higher score compared to students who scored below 50% (low-performance students, n=25) in lab practical sessions (p<0.001). Group scores among students who had low performance were statistically significantly higher compared to their individual scores. This was also observed among high performance students (Figure 1).

Table 01. Mean scores in 8 lab exercises at individual and at group level (min-max 0-100)

Level	Group 1	Group 2	Group 3	Group 4	Group 5
Individual score	44.0 ± 11.8	45.5 ± 14.0	45.1 ± 7.6	44.0 ± 12.2	50.0 ± 7.6
Group score	82.5	77.5	80.0	77.5	75.0
p-value for difference*	0.001	0.001	0.001	0.001	0.001

*Wilcoxon signed rank test
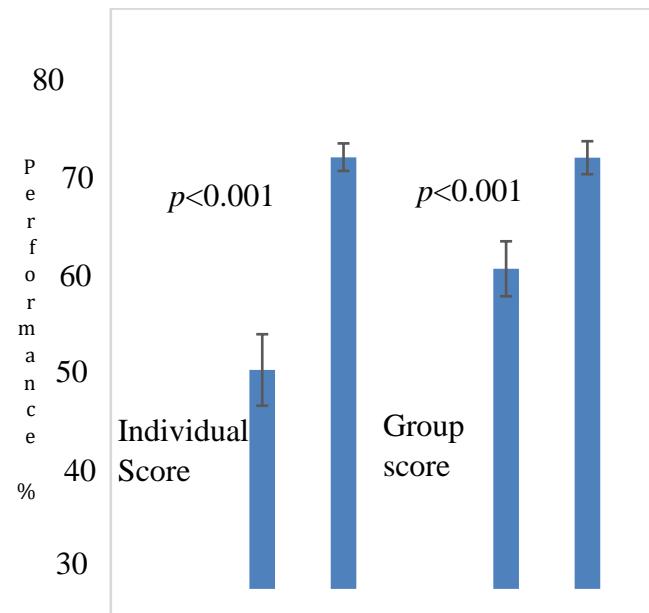
Figure 01: Mean scores in 8 lab exercises at individual and at group level among low and high performance students (min-max 0-100)

Low performant students High performant students*Wilcoxon signed rank test; Low performance students' score 0-50, high performance students' score 51-100.Table 2 displays attitude scores of 26 students about lab learning experience in groups. Overall, all average scores were positive. The highest scores were observed for "Promotes opportunity for active learning" (4.6 out of 5), "Group dynamics potentiate learning outcome" (4.6 out of 5) and "Encourage discussion for differential diagnosis" (4.6 out of 5). None of the attitudes was correlated with the grade obtained after the exam. No difference in attitudes was found between high and low performing students.

Table 02: Attitude scores toward group lab work

| Item	Mean (SD)	Median (IR)
1. Increase interaction between students	4.5 (0.3)	5.0 (1.0)
2. Create sense of community	4.5 (0.3)	5.0 (1.0)
3. Promotes confidence in application of knowledge for problem solving	4.3 (0.6)	5.0 (1.0)
4. Promotes opportunity for active learning	4.6 (0.6)	5.0 (1.0)
5. Group dynamics potentiate learning outcome	4.6 (0.6)	5.0 (1.0)
6. Permits opportunities for leadership development	4.1 (0.8)	4.0 (2.0)
7. Helps to integrate concepts taught in classes	4.4 (0.6)	4.5 (1.0)
8. Encourage discussion for differential diagnosis	4.6 (0.6)	5.0 (2.0)

Legend: 1- strongly disagree; 2 - disagree; 3 - neutral: 4 - agree; 5 - strongly agree; SD-standard deviation; IR-interquartile range.

Discussion

Since 2013, Trinity Medical Sciences University (TMSU) has switched from light microscopy (LM) to virtual microscopy (VM) in the analysis of pathohistological slides. Wilson et al.[11].showed that VM is superior to LM for learning. Our previous results point to the conclusion that working in a group during the annotation of slides students achieve better results (data not published), indicating the importance of teamwork in student education. In this study, we analyzed the effect of teamwork in establishing the correct pathohistological diagnosis. Our results show that the average group scores in 8 lab practical sessions in all five experimental groups are statistically better compared to the individual results that the students had in those groups (44.0% to 50.0% and 75.0% to 82.0%, respectively, $p<0.001$). This result agrees with the finding of Wiener H et al [12].The authors found a favorable influence of TBL on males' examination score compared to females, assuming that this difference may represent the cultural context in which the research was conducted. We did not consider this issue in our study. The differences between the groups were not observed.

Some of the earlier studies showed that teamwork benefits more academically successful students [13, 14], suggesting that they are more motivated than their lesser-achieving counter-part. There are also studies that concluded that TBL may benefit only students with lower academic success and who need to be helped by other team members [15]. Contrary to that, our results show for both groups (low performers as well as high-performance students) a statistically significant benefit from learning as part of a team in diagnosing pathohystological slides ($p<0.01$) which is consistent with our previous results [1]. This agrees with the findings of other authors who find that TBL increased overall academic performance, especially in weaker students [14, 16]. As shown in Figure 1 weaker students working in a group increased their scores by 38.7% (from 39.8% to 78.5%, $p<0.001$) while stronger students increased their scores by 20.2% (from 58.2% to 78.4%, $p<0.003$). Kibble et al [15] showed that the success of TBL depends on high-functioning student teams. Characteristics such as academic success, sex, ethnicity and age of the students were balanced in our groups, so there was no statistically significant difference between the groups in diagnosis of pathohistological slides.

Overall, the perception of TBL as a learning method in analyzing pathohistological slides and making diagnosis was positive and was well received by the students enrolled in

Systemic Pathology course at TMSU. All average scores were positive. The highest scores were observed for "Promotes opportunity for active learning", "Group dynamics potentiate learning outcome" and "Encourage discussion for differential diagnosis". Team-based work also increase interaction between students by sharing annotation on a common image layer, discussion about the findings that create a sense of community. This helps to integrate knowledge taught in class, promote confidence in application of knowledge for problem solving and provide opportunities for leadership development, the results which are in accordance with findings of other authors [17, 18]. None of the attitudes was correlated with the grade obtained after the exam and no difference in attitudes was found between high and low performing students.

Limitations

Considering the number of students (n=36), this study is underpowered and this research could have benefitted from a larger sample size. Nevertheless, this preliminary study shows a statistically significant difference in the result in favor of teamwork in the diagnosis of pathohistological slides. In order to better quantify the improvement through teamwork, students know in advance from which organic system they will have slides for analysis. Participation in the study is voluntary and participants can withdraw at any time. Participants also know that the results of the exercises do not affect their grade in pathology, which may raise the question of their motivation in the test. The students are also limited in time when analyzing the slides, so that the learning environment is not completely free CSCL environment. We believe that these limitations do not cause biased results in favor of collaborative or individual analysis. The study continues and with the increase in the number of students in the examination, some of the limiting factors will be removed.

Conclusion

Our preliminary results show that working in a small groups significantly improve students' results in making diagnosis of pathohistological slides in both academically weak and academically strong students. TBL also increases interaction between students, create sense of community, promotes confidence in application of knowledge for problem solving, promotes opportunity for active learning and helps to integrate concepts taught in classes. This promotes opportunity for active learning and permits opportunities for leadership development. Group dynamics significantly potentiate learning outcome.

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Conflict of interest
The authors declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study

Ethical Statement

Study Reflections ethical standards

Author Contribution

The authors have contributed equally to this work.

References

1. Jovanovic, D., Gazibara, T., Solanki, R., Ackerman, C., Satkovich, E. (2020). Perception of health-related case studies in the context of introduction to clinical medicine course: student's and teachers' perspective.Ir J Med Sci, 189(1):373-379.
2. Blouin, R. A., Riffee, W. H., Robinson, E. T.,Beck.,D. E., Green, C., Joyner, P. U.,et al. (2009). Roles of innovation in education delivery. Am J Pharm Educ. 73(8), Article 154.
3. Haidet, P., Morgan, R. O., O'Malley, K., Moran, B.J., Richards, B. F. (2004). A controlled trial of active versus passive learning strategies in a large group settings. Adv Health Sci Educ. 9:15-27.
4. Subramanian, A., Timberlake, M., Mittakanti, H., Lara, M., Brandt, M. L. (2012). Novel educational approach for medical students: improved retention rates using interactive medical software compared with traditional lecture-based format. J Surg Educ. 69:449-452.
5. Sisk, R. J.(2011). Team-based learning: Systemic Research Review. J. Nursing Education. 50(12):665-9.
6. Kumar, R.K., Velen, G. M., Korell, S. O., Kandara, M., Wakefield, D. (2004). Virtual microscopy for learning and assessment pathology. J Pathol. 204(5):613-8.
7. Fonyad, L., Gerely, L., Cserneky, M., Molnar, B., Matolcsy, A. (2010). Shifting gears higher-digital slides in graduate education-4 years experience at Semmelweis University. DiagnPathol. 5:73.
8. Sahota, M., Leung, B., Dowdell, S., Velan, G. M.(2016). BMC Medical Education. 16:311.
9. Simon, P. (2011). Case study research: design and method. Eval Res Educ 24(3):221-222.
10. Keen, J., Packwood, T. (1995). Qualitative research: case study evaluation. BMJ 311(7002):444-446.
11. Wilson, A. B., Taylor, M. A., Klein, B. A., Sugrue, M. K., Whipple, E. C., Brokaw, J. J. (2016). Meta-analysis and review of learner performance and preference: virtual versus optical microscopy. Med Educ. 50(4):428-40.
12. Wiener, H., Plass, H., Marz, R. (2009). Team-based learning in intensive course format for first-year medical students. Croat Med J. 50(1):69e76.

13. Woo, Y., Reeves, T.C. (2007). Meaningful interaction in web-based learning: A social constructivist Interpretation. Internet High Educ. 10(1):15-25.

14. Letassy, N. A., Fugate, S. E., Medina, M. S., Stroup, J.S., Britton, M.L. (2008). Using team-based learning in an endocrine module taught across two campuses. Am J Pharm Educ. 72:1-6.

15. Kibble, J. D., Bellew, C., Asmar, A., Barkley, L. (2016). Team-based learning in large enrolment classes. AdvPhysiol Educ. 40:435-442.

16. Koles, P. G., Stolfi, A., Borges, N. J., Nelson, S., Parmelee, D. X.(2010). The impact of team-based learning on medical students' academic performance. Acad Med. 85:1739-1745.

17. Husmann, P.R., O'Loughlin, V. D., Braun, M. W. (2009). Quantitative and qualitative changes in teaching histology by means of virtual microscopy in an introductory course in human anatomy. AnatSci Educ. 2(5):218-26.

18. Bridge, P., Trapp, J. V., Kastanis, I., Pack, D., Parker, J.C. (2015). A virtual environment for medical radiation collaborative learning. AustralasPhysEngSci Med. 38(2):369-74.