RESEARCH ARTICLE

Comparison of individual and group learning in different laboratory settings among third year Medical Technology students

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ABSTRACT

Background and Objectives: To learn technical skills in Medical Technology schools, laboratory experiments are made individually or in groups. The nature of student participation and effect of group work in laboratory skills and attitudes of students have not been well studied. The study compared individual work, working in groups of three, and working in groups of six in terms of skills and attitudes toward learning, motivation to learn, responsibility, helpfulness, and teamwork.

Methodology: Experimental study was used that employed a counter-balance design among thirty-six third-year medical technology students who were instructed to learn laboratory skills in three settings and were rotated in six experiments. Performance examination and questionnaires were formulated by the researcher and used for gathering data. One-way ANOVA was used to determine the significant differences among practical exam scores of the three laboratory settings while Kruskal-Wallis H and Mann-Whitney U test were used to determine differences in rating scores of the attitude questionnaire.

Results and Conclusions: There were no significant differences in students' skills $F(2, 213)=1.97$, ($p=.142$) and in their attitude toward learning, helpfulness and teamwork among the laboratory settings. Students have higher motivation when working in groups ($H(2)=14.413$, $p=.001$) and assumed more responsibility when working alone than when working groups. When students worked individually or in groups of three, they perceived ending up doing most of the work.

Keywords: *working in groups, individual work, medical technology, learning outcomes, skills, attitude*

Introduction

Medical technology students need to go through rigorous training particularly in the laboratory setting to achieve the knowledge, skills, professional attitude, and values in the performance of clinical laboratory procedures [1]. One of the professional courses in Medical Technology is analysis of urine and other body fluids. It involves the macroscopic or physical examination, chemical and microscopic analysis of urine and covers special tests performed on other body fluids. The course enables students to perform skillfully the routine and special laboratory methods employed in the proper handling, examination and disposal of different body fluids and secretions. Students are also able to apply analytical and critical thinking; determine acceptability of samples within guidelines; test samples according to standard methods and techniques; and take appropriate actions to maintain accuracy and precision in the clinical laboratory [1].

Several strategies are being used to ensure achievement of said competencies. Hands-on methods serve as an aid for individual work and provide students with concrete experiences. Learning individually can potentially help students make decisions on their own, helps them achieve higher rate of satisfaction, and increases motivation [2,3]. On the other hand, working in groups promotes interaction and active involvement. Medical Technology students prefer a more kinesthetic type of learning, which require more physical activity. A mentor or "buddy" system is recommended to help them learn, which encourages them to be open among their peers to increase interaction and motivation. Likewise, in higher education, group work approach was commonly used

as an effective teaching and learning tool, which improves responsibility, positive interdependence and motivation to achieve than working individually [4]. Further, students practice interpersonal skills, teamwork, greater participation, and self-confidence [5].

On the other hand, there are also negative aspects of working in groups. Students encountered problems such as member's unwillingness to work in the group; free rider members would not participate or contribute to the group. Also, students who gained the most were those with lower ability students compared with the higher ability students [6]. It is not only individual work versus group work that should be considered. When working in a group, the size of the group may affect the productivity and effectiveness of students. The group size should have sufficient number of students to participate and perform work while avoiding social loafing, free-riding, and conformity problems that can be triggered when groups become larger [7]. The opportunity of student's interaction decreases when group size increases [8].

Whether working individually or in groups is better in achieving learning outcomes has not been established. Furthermore, the group size is likewise not yet settled. The laboratory setting is an essential setting for medical technology students. Therefore, the study compared the learning outcomes between individual work and working in groups of the different laboratory settings (individual work, group of three and the group of six) in terms of skills and attitudes toward learning, motivation to learn, responsibility, helpfulness, and teamwork.

Methodology

Experimental study was used that employed a counter-balance design. Each participant serves as their own control and multiple interventions can be tested at the same time. The study was conducted during the first semester of school year 2017 - 2018. It started from August 2018 up to December 2018. In other words, the researcher can identify the main effects due to condition and can control for order and sequence effects. Variation in level of difficulty of a particular experiment, fatigue factor after repeated experiments are controlled since in these designs, each participant served as the control and experimental groups. All students participated in all experiments and worked in all laboratory settings (individual, in groups of three, in groups of six), in equal frequency (two experiments per student). Moreover, students were randomized to one of the possible sequences of laboratory settings (1-3-6, 1-6-3, 3-1-6, 3-6-1, 6-1-3, 6-3-1).

Participants

The participants are enrolled in a private non-sectarian School of Medical Technology in Manila. There were one hundred 3rd year medical technology students. Of these, thirty-six third year medical technology students volunteered to participate and were officially enrolled for the clinical microscopy course during the 1st semester of 2017-2018. Each was either a transferee or a regular student. One hundred percent of the participants in the study had not taken the course and was taking it for the first time. Students with an irregular status or a transferee medical technology student who already took the course at least once were excluded. Students who were willing to participate had enlisted their names and gave their informed consent. The student, who completed and submitted their consent, drew a piece of paper from the lot indicating their code number. Their names were listed by the laboratory technician along with their code number which they would be using throughout the study. The code number given to the students had a random sequence for each experiment.

Sample Size Calculation

Computation of sample size was adopted from Becker's calculation [9] using estimation of the difference between two groups (*i.e.*, 60% of the standard deviation), setting the power to detect a significant difference between any two groups at more than 90% and the level of significance at 0.05 The sample size or number of observations needed was calculated to be 72. Given three laboratory student groupings (group of six, group of three and individual), six laboratory experiments and two observations per student, the seventy-two observations were achieved with 36 students.

Instrumentation

This study utilized two researcher-made instruments in gathering the data. A practical examination rating scale was developed by the researcher and was validated by two content experts and was used to measure the skill and ability of students to perform the steps of six experiments. The instrument followed a three-point rating scale with 1-Poor (student failed to complete task), 2-Fair (Student completed task with some errors), and 3-Good (Student performed the task with no error). Using Angoff's method, the minimum passing level (MPL) was 64%. The number of items of the practical examination rating scale differs in each experiment. For experiment number one, the number of items of the practical examination rating scale was eight items. For

experiment number two, it consisted five items. For experiment number three and number four, it comprised six items. For experiment number five and six, it had twelve items. No revision was made for the practical examination rating scale.

An attitude questionnaire was composed of five parts namely attitude towards learning, motivation responsibility, helpfulness and teamwork. This used a 4-point Likert scale where 1 is strongly agree, 2 is agree, 3 is disagree, and 4 is strongly disagree. The number of items for the attitude towards learner had twelve items. For motivation to learn, it consisted of three items, whereas for responsibility it had four items. Both helpfulness and teamwork had four items. This was face validated by two experts both who are adept in instruction, assessment and in research. The questionnaire was and pilot tested among twenty-one 4th year medical technology students. For internal consistency Cronbach's alpha was utilized, which yielded 0.836 indicative high internal consistency of the items in the instrument. Revision was made in the attitude questionnaire for item number nine in the attitude toward learning part. Also item number twenty four in the teamwork part was revised.

Data collection and analysis

Practical examination was individually given to all participants. The teacher observed and evaluated individual performance using a 3-point rating scale. Furthermore, after performing the different laboratory experiments each participant rated his or her attitude using an attitude questionnaire with a 4-point-Likert scale. The students were given a questionnaire for attitudes towards learning, motivation, responsibility, helpfulness and teamwork. They rated themselves after performing the different laboratory experiments.

For data analysis several statistical measures were utilized. One-way ANOVA was used to determine the significant differences among the means of the practical exam scores of students from the three laboratory setting while Kruskal-Wallis H was used for the responses of student on the first three parts of the attitude questionnaire, which were attitudes toward learning, motivation to learn, and responsibility. It was used to determine if there are statistically significant differences between the three laboratory settings. Moreover, Mann-Whitney U test in SPSS was used to compare the differences between the two groups which were working in group of three and working in group of six on the ordinal responses of students on attitudinal questionnaire which consist the Fourth part – helpfulness and Fifth part – teamwork.

Ethical Considerations

The researcher sought permission from the non-sectarian School of Medical Technology in Manila to conduct the research study among Medical Technology students. During the meeting with the 36 participants, the researcher oriented, sought for their consent, and assured confidentiality as well. Moreover, the researcher was mindful of the data privacy law and the following ethical considerations (1) The participant's involvement is purely voluntarily (2) The choice that the participants made had no bearing on their grades or standing in any of their classes (3) They may change their minds later and withdraw participation even if they agreed earlier in the study. This too did not affect their grades or class standing (4) The practical exam scores, attitude responses, perception responses, roles and interactions were coded and did not include their names to ensure privacy. The principal investigator and data collectors were not familiar with the student's individual ratings (5) Participants were made aware of the risk of their exposure to urine and stool samples during experimentation as this could cause laboratory-acquired infections. They were also aware that laboratory injuries can occur if they would not properly wear their individual personal protective equipment during the laboratory experimentation (6) The participant understood also that it was not possible to identify all potential risks in an experimental procedure, and that reasonable safeguards were made to minimize both the known and the potentially unknown risks. Likewise, the study was reviewed and approved by the University of the Philippines Manila Research Ethics Board (UPMREB 2017-449-01) prior to its implementation.

Results

The study compared individual work, working in groups of three, and working in groups of six in terms of skills and attitudes toward learning, motivation to learn, responsibility, helpfulness, and teamwork.

Practical examination results

Table 1 shows students who performed individual work in a laboratory experiment performed the same (M= 97.4, SD = 3.42) as students working in groups of 6 (M= 97.00, SD = 4.17) and with students working in groups of 3 members (M=96.1, SD=4.76). ANOVA revealed no significant differences among laboratory settings F(2, 213)=1.97, (p=.142). The set skills of the practical examination involve time management, independence, work ethic, adaptability, analytical and communication skills.

Table 1. *Individual and group learning Mean and SD practical examination scores (n=72)*

Laboratory setting	Mean	*SD*	dF	*F*	*P* Value
Individual work Working in Groups of 3 Working in Group of 6 Total	97.4 96.1 97.0 96.8	3.42 4.76 4.17 4.17	2,213	1.97	.142

Table 2. *Individual and group learning Mean ranks of students attitude toward learning (n=72)*

Statements	Group	Mean Ranks	dF	*H*	*P* Value
1. I am confident in doing the work alone	Individual Group of 3 members Group of 6 members	102 115 108	2	2.082	.353
2. I am confident in doing the work with a group	Individual Group of 3 members Group of 6 members	117 98.8 108	2	4.197	.123
3. I learn better on my own	Individual Group of 3 members Group of 6 members	99.3 112. 114	2	2.832	.243
4. I learn better working with a group	Individual Group of 3 members Group of 6 members	110 105 109	2	.270	.874
5. I am satisfied working alone	Individual Group of 3 members Group of 6 members	106 112 108	2	.433	.805
6. I am satisfied working with a group	Individual Group of 3 members Group of 6 members	110 106 110	2	.292	.864
7. I learn from the feedback from my group members	Individual Group of 3 members Group of 6 members	113 108 105	2	.711	.701
8. The material is easier to understand when I work with other students	Individual Group of 3 members Group of 6 members	115 99.6 111	2	3.051	.217
9. I learn to work with students who have different learning styles from me	Individual Group of 3 members Group of 6 members	112 106 107	2	.513	.774
10. I feel working in groups is not a waste of time	Individual Group of 3 members Group of 6 members	106 105 102	2	.239	.887
11. I learn more information when I work with other students	Individual Group of 3 members Group of 6 members	109 107 110	2	.078	.962
12. I believe I can work effectively with other groups in the future	Individual Group of 3 members Group of 6 members	109 104 112	2	.925	.630

Questionnaire Results on Attitude toward learning

Kruskal Wallis H Test was used to analyze the statements 1-19 of students attitudes toward learning, motivation to learn, and responsibility. Table 2 shows statements 1-5 indicated no statistically significant difference on the attitude toward learning between the different laboratory settings.

Furthermore, Table 2 showed no statistically significant difference on the attitude toward learning of statements 6-12 between the different laboratory settings.

Questionnaire Results on Motivation to learn

Table 3 shows the attitudinal questionnaire for motivation to learn. A significant difference can be seen with students' response on motivation to study on their own between the different laboratory settings, (H(2)=6.253, p=.044, with a mean rank of 98.3 for students in individual work, 121 for students working in groups of 3 and 105 for students working in groups of 6. Furthermore the Kruskal-Wallis H test was used on statements 14 and 15 which showed no significant difference between the different laboratory settings.

Questionnaire Results on Responsibility

Table 4 showed a statistically significant difference in students' response on being responsible when performing a task alone between the different laboratory settings, (H(2)=14.413, p=.001, with a mean rank of 89.2 for students from individual work, 122 for students working in groups of 3 and 113 for students working in groups of 6. Also, there was a significant difference in students' response to the statement, "When I work in a group, I do not end up doing most of the work" among the different laboratory settings, (H(2)=6.470, p=.039, with a mean rank of 113 for students

Table 3. *Mean ranks of students' motivation to learn indifferent laboratory settings (n=72)*

Statements	Group	Mean Ranks	dF	*H*	*P* Value
13. I am encouraged to study on my own	Individual Group of 3 members Group of 6 members	98.3 121 105	2	6.253	.044*
14. I am encouraged to study with a group	Individual Group of 3 members Group of 6 members	110 100 114	2	2.469	.291
15. The material is more interesting when I work with other students	Individual Group of 3 members Group of 6 members	112 99.1 113	2	2.906	.234

* Statistically significant at *P*<.05

Table 4. *Mean ranks of students' responsibility indifferent laboratory settings (n=72)*

Statements	Group	Mean Ranks	dF	*H*	*P* Value
16. I feel responsible when performing the task alone	Individual Group of 3 members Group of 6 members	89.2 122 113	2	14.413	.001*
17. I feel responsible when performing the task with a group	Individual Group of 3 members Group of 6 members	115 99.2 112	2	3.178	.204
18. When I work in a group, I do not end up doing most of the work	Individual Group of 3 members Group of 6 members	113 115 94	2	6.470	.039*
19. I try to make sure my group members learn the material	Individual Group of 3 members Group of 6 members	109 101 114	2	2.480	.289

* Statistically significant at *P*<.05

from individual work, 115 for students working in group of 3 and 94 for students working in groups of 6. However, results of students' responsibility in different laboratory settings for statements 17 and 19 showed no significant difference between the different laboratory settings.

Questionnaire Results on Helpfulness

Furthermore, Mann-Whitney U test was applied for statements 20-27 to measure the attitude of the participants' individual and group learning.

Table 5 shows the students' helpfulness for statements 20 -23 which indicated no significant difference between the two laboratory settings.

Questionnaire Results on Teamwork

Table 6 shows the students' teamwork in different laboratory settings on statements on 24, 25, 26 and 27 indicated no significant difference between the two laboratory settings.

All scores of the students in the practical examination in the three settings were not significantly different from each other. Attitudes of students in all three settings were favorable towards learning, motivation, and responsibility. There was no significant difference in their perceived confidence, satisfaction and perceived usefulness of the setting that they were in. Students doing individual work and working in group of 6 preferred individual work while students in group of 3 preferred that setting. The students' level of motivation and responsibility was also significantly higher in those doing individual work. Students perceived that they learned better in a group but they perform the experiment better when doing individual work.

Students, who worked in a group, whether group of three or group of six, reported positive responses to teamwork and helpfulness.

Discussion

The study of Enrera [7] supports the results of this study that indicate whether students who work individually and

Table 5. *Mean ranks of students' helpfulness in two laboratory settings (n=72)*

Statements	Group	Mean Ranks	*Z*	*U*	*P* Value
20. My group members help me explain things I do not understand	Group of 3 members Group of 6 members	74.0 71.0	-.500	2482	.617
21. When I work in a group, I am able to share my ideas	Group of 3 members Group of 6 members	71.5 73.5	-.323	2523	.747
22. My work is better organized when I am in a group	Group of 3 members Group of 6 members	70.8 74.2	-.572	2468	.567
23. My group members like to help me learn the material	Group of 3 members Group of 6 members	73.2 71.8	-.252	2541	.801

Table 6. *Mean ranks of students' teamwork in two laboratory settings (n=72)*

Statements	Group	Mean Ranks	dF	*H*	*P* Value
24. When I work with others, I am able to work at the pacing of the group	Group of 3 members Group of 6 members	69.5 75.57	-.965	2379	.334
25. The work becomes easier to complete when I work with other students	Group of 3 members Group of 6 members	6.5 67.5	-1.435	2335	.151
26. The workload is usually less when I work with other students	Group of 3 members Group of 6 members	72.2 72.8	-.111	2568	.912
27. It takes less time to complete the task when I work with others.	Group of 3 members Group of 6 members	72.4 71.6	-.036	2527	.892

or who work in different group sizes still learned the procedural skills required in each experiment. Also, they are actively involved in the experiments and became familiar with the steps in the experiments.

Students' attitudes toward learning were quite stable. Most agreed with all the items on attitude toward learning for statements "I am confident in doing the work alone", "I am confident in doing the work with a group", "I learn better on my own", "I learn better working with a group", and "I am satisfied working alone". Students' attitudes were positive all throughout the six experiments. The more time students spent longer in groups, the more positive their attitude became.

The study showed that students who were actively involved in the group task facilitated the development of a core of positive attitudes toward learning since self-confidence was one of the positive attitudes found in group learning. This finding is similar to that of Anderson [10].

Students in the different laboratory setting were satisfied working in a group. Students in the individual work performs a certain task will get feedback from their teacher while students working in groups will receive more feedback from their group members. Students performing a task with a group are able to ask their members if they are performing the task correctly. When a group member performs a task, the other members would observe and would be able to provide feedback or correction right away. This allowed students to gain a more accurate picture of how others see them perform the task.

There was no significant difference among the ratings by students in the three different settings for statements "The material is easier to understand when I work with other students", "I learn to work with students who have different learning styles from me", "I feel working in groups is not a waste of time", "I feel working in groups is not a waste of time", "I learn more information when I work with other students", "I believe I can work effectively with other groups in the future". Students understood the material easier when they worked with each other because their group members could strengthen or clarify what the experiment was all about, and how to perform it. Group members provided inputs and feedback from each other which agreed with Kolb [11] who stated that students encountered new experiences when they observed their classmates and learned new concepts when they reflected and discussed together.

Students were able to work with other students with different learning styles. They were able to adapt with different group members to attain the objective. This finding supports those of Dennicka [12]. Students from each group learned to respect and help the others to learn and were also more open to others' point of view.

There was a significant difference between students' response on motivation to study on their own in the different laboratory settings. Students from individual work (M=1.45, SD=0.529) were more motivated to learn when performing individual work than students working in groups of 3 (M=1.72, SD=0.676) and groups of 6 (M=1.53, SD=0.581). However, there was no significant difference for the responses of students in the different laboratory setting for the statement "I am encouraged to study with a group" and "The material is more interesting when I work with other students". They were motivated to study on their own or with a group and became more interested with the material when working with others. They were able to check their understanding through interactions with each other and with the course material.

There was a significant difference on the perception of students on responsibility when performing the task alone from the different group setting while no significant difference on the responses for the statement "I feel responsible when performing the task with a group". Students who performed individual work became more responsible when performing a task alone compared with students working in groups of 3 or 6. Students had control and choice with their learning and are motivated when working alone. These coincide with Jeong's [3] study, which state that students who were performing a certain task felt responsible because they did not have other members to rely on and had to attain the goal on their own. They had a sense of independence and reflected that being responsible was the key point in urging them to finish the experiment satisfactorily. While, a student who was in a group became responsible during division of the task, they would accept the responsibility, if no one elicits the responsibility, one member would accept the responsibility in order to start the task and attain the objective or goal. Whereas, Hansen [13] stated that it would be necessary that all group members take part and make an effort to take part in the group work. This corroborates with Strijbos' [14] study which maintains that all group members should feel a sense of personal responsibility for the group's success.

There was significant difference on the response toward group work, with the statement "They do not end up doing most of the work." Students who performed the individual

work and group of three members disagreed, indicating a negative response. While students from the group of six members showed a positive response toward this item. Students working in group of six, the group members delegated the task among themselves so that each member took responsibility and attained the groups' output which conforms with Strijbos [14] that group work develops positive interdependence. For those with smaller number of students, they perceived that most of the task became their sole responsibility because either the task was simple and could be made by a single person, or the division was not equal and some had greater tasks than others. This became a challenge among members with three members. Strijbos [14] affirms that members working in a group were more motivated to achieve than working individually.

There was no difference between responses of students working in groups of three with students working in groups of six for the statements "My group members help explain things I do not understand', "When I work in a group, I am able to share my ideas", "My work is better organized when I am in a group", "My group members like to help me learn the material".

Students in both laboratory setting indicated a positive response. They agreed that helpfulness occurred when members of their groups helped explain things or procedures that were not clear to them, shared ideas, enabled them to organize their work, and helped them learn the material. Students in the group ensured that together they succeeded with the experiment. This agrees with the study of Ladyshewsky [15], which reported that the success of cooperative team shows student outcomes to be positive in terms of academic achievement and promotes higher achievement rather than with competition or individual efforts.

There was no significant difference between the two laboratory settings on students response for the statements "When I work with others, I am able to work at the pacing of the group", "The work becomes easier to complete when I work with other students", "The workload is usually less when I work with other students" and "It takes less time to complete the task when I work with others". Most of the students who were working in groups of three and working in groups of six showed positive response on teamwork. Students are able to catch up with the groups work because their members do not pressure their members to finish the work on time. Since the task can be divided among group members, the workload becomes less at the same time the work is done faster for each member particularly working in groups of six. Similar were the findings of Payne [16] on students working in groups.

Conclusion

In summary, this study showed that the skill performance, attitude toward learning, helpfulness and teamwork of students in the three group settings did not significantly differ from each other. Students had higher motivation when working individually and assumed more responsibility when working alone than when working in groups when performing laboratory experiments. Thus, the study will hopefully contribute to the development of medical technology graduates who are confident working alone and comfortable working in groups in the workplace.

Since data came from one subject in the medical technology course, it is recommended to use group work from other different subjects. Also, the study only utilized a maximum of six members per group, to increase the number of participants in a group is recommended.

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