Teachers' Engagement in the Conduct of Lesson Study in Teaching Statistics

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Abstract– *The quality of mathematics education is dependent to the kind of teachers we have in the classrooms. One of the practical ways, yet found to be effective, in enhancing teachers' quality in teaching mathematics and improving students' performance is through Lesson Study (LS). This study, using descriptive-correlational design, determined the effects of LS in enhancing self-efficacy, attitude, pedagogical and content knowledge of teachers in teaching Statistics among senior high school students. All 8 senior high school teachers of a school in the Division of City Schools, Naga City, participated in this study. Surveys, observations (performance indicator checklist), reflection entries, and focus group discussion (FGD) were used as methods in explaining and validating teachers' responses. Findings revealed that 2 research lessons (RLs) in Statistics were developed following the LS cycle. These RLs were considered as the least learned topics and big gaps in Statistics. The nature of teachers' engagement across stages of LS cycle was characterized as less collaborative and the extent of engagement was described as partially engaged. Also, the experiences and processes of LS cycle brought positive yet moderate effect along teachers' self-efficacy, content knowledge (CK), pedagogical knowledge (PK), and attitude towards teaching Statistics.*

Keywords – *attitude towards teaching and learning Statistics, content knowledge, Lesson Study, pedagogical knowledge, self-efficacy.*

INTRODUCTION

Quality education is viewed as the country's pillar of success [1]. Emphasis on providing quality education is one of the top priorities of every country. Over the past decades, the concerns on giving quality mathematics education and the perennial problem of the low academic performance of students in Mathematics have been around and still among the favorite topics of mathematics researchers and educators. The government has been continuously upgrading, improving, and innovating to respond to this perennial problem. One of the recent efforts made by the government is the reform in the curriculum through R.A. 10533 or famously known as the "K to 12 Curriculum" in year 2013. While this educational reform may be promising and exceptional but one critical component that must be taken into consideration is opportunity and support structure to those who directly deals with students—the teachers [2]. Any reform should be accompanied by concrete and appropriate professional development program for teachers [1]. Since the success of any educational reform will be dependent on how the teachers will implement such reform [3].

In the face of challenging situation in uplifting and improving the mathematics performance of students, one cannot simply overlook the situations of teachers in every classroom. Evidence unequivocally shows that good teachers are vital to raising student's achievement. The question, "What constitutes an effective mathematics teacher?" remains a contentious issue in mathematics education. The Department of Education (DepEd), through the Research Center for Teacher Quality, highlighted the critical role of the teacher's knowledge on content and pedagogical knowledge (PCK) of Shulman as an important quality of a teacher. This can be seen as the first domain in the Philippine Professional Standards for Teachers (PPST) [4].

Under the K to 12 program, the senior high school (SHS) curriculum is just on its third year of implementation. It can be observed that the topics included in mathematics subjects are the topics that are usually being taught in tertiary level. Also, it can be observed that teachers handling these subjects, in Statistics for example, have no in-depth training or are considered novices in teaching the said topics. For this reason, teachers are having low self-efficacy or are developing negative disposition towards the subject that radiates to the students. Teachers' self-efficacy is a crucial variable in increasing the quality of education, in classroom management, in increasing student's

achievement, in the use of method and strategy and in increasing student motivation and success [5]. Chan [6] viewed the same notion and stated that there were many researchers that considered teacher efficacy as a crucial factor in improving teacher education and in promoting education reform (e.g., Ashton, 1984; Goddard, Hoy & Woolflock, 2000; Ross, 1998; Scharmann & Hampton, 1995).

With the dynamics of curriculum policy and the continuous reform in education, a responsive, localized, and bottom-up training programs are expected. This will keep the teachers abreast with any reform and at the same time make the teachers ready to the challenges ahead of them. And one of the emerging and viable models in the Philippines that captures most of the qualities and elements of an effective and quality PD is the Japanese Lesson Study or simply Lesson Study (LS). This has been proven effective in Japan and is now being implemented in many countries [3]. LS presents strong evidence of teachers' effectiveness as seen in students' achievement [7].

Not much is known on how teachers learn and how teacher learning compares with student learning. However, one of the emerging theories for adult learners is the Adult Learning Theory of Malcolm Knowles (1978). Knowles developed this theory into a method called andragogy [8]. Knowles suggested the following assumptions that guide his view of adult learning: (a) adult learner moves from dependency to increasing self-directedness as he/she matures and can direct his/her own learning; (b) adult learner draws on his/her accumulated reservoir of life experiences to aid learning; (c) adult learner is ready to learn when he/she assumes new social or life roles; (d) adult learner is problem-centered and wants to apply new learning immediately; and (e) adult learner is motivated to learn by internal, rather than external factors [9]-[12].

Teachers should be given latitude to form their own professional development. What interests them? What would they like to delve into more deeply? What do they feel they need to learn? Allowing the teachers to determine what direction their professional development will take will greatly increase the success of the teachers in their journey to be lifelong learners [13]. This concept is what professional development program should look like and what the teachers needed, a bottom-up approach that caters and addresses the teacher's need in school setting. Knowles andragogical message is that effective adult teaching begins where the students are [13].

Inherent to Knowles' assumptions are implications to practice. Knowles [12] posited that adult education should: (a) set a cooperative climate for learning in the classroom; (b) assess the learner's specific needs and interests; (c) develop learning objectives based on the learner's needs, interests, and skill levels; (d) design sequential activities to achieve the objectives; (e) work collaboratively with the learner to select methods, materials, and resources for instruction; and (f) evaluate the quality of the learning experience and make adjustments, as needed, while assessing needs for further learning. And all these implications are embedded in LS specifically in the process called "kyozaikenyu."

In the Philippines, the University of the Philippines National Institute of Science and Mathematics Education Development (UPNISMED) has been strongly advocating LS. In the Bicol region, LS was first introduced in Ligao National High School, Ligao City in August 2012. While in the Division of City Schools—Naga City, LS is relatively new and is just being explored and studied. There were seminars, trainings, and workshops that have been conducted to some selected elementary and secondary Mathematics teachers around the area to capacitate them in implementing LS in school. However, the implementation of LS becomes a little bit problematic due to some internal and external factors that resulted to misconception of the teachers in implementing LS particularly during the early stage. It is at this vantage point that the desire of the researcher grows even more in embarking on studying LS as one professional development model in enhancing the teacher's quality in teaching Statistics. There were very few studies conducted in the Bicol region that use LS particularly in teaching Statistics among senior high school students.

OBJECTIVES OF THE STUDY

This study determined the nature and level of teachers' engagement and effects of using LS as part of professional development program among the senior high school Statistics teachers. Specifically, it aims to determine: (1) the lessons in Statistics that can be developed by teachers through LS; (2) the nature and level of teachers' engagement in the different stages of LS; and (3) the effects of teachers' engagement on their self-efficacy, attitudes towards teaching Statistics, content knowledge, and pedagogical knowledge of the teachers.

METHODS

Research Design

The descriptive-correlational design was used in determining the nature, level, and effects of teachers'

engagement in the different stages of LS cycle. The descriptive design was utilized in profiling and characterization of the teacher-participants along self-efficacy, attitude, CK, PK, and level of engagement across the different stages of LS. Data were collected with the use, mainly, of surveys. Furthermore, to test the validity through convergence of information, and at the same time to add more depth to the present study, triangulation technique was used. Reflection entries, observations (performance indicator checklist), interviews, and FGD were considered and analyzed.

The correlational design, on the other hand, was used to determine the kind of relationship between the level of engagement of teacher-participants and the perceived self-efficacy, attitude towards teaching and learning Statistics, content knowledge and pedagogical knowledge.

Participants

The participants of this study includes all 8 senior high school mathematics teachers in one school in Naga City. Being the largest and the most populated school in the city, the said school is considered as one district of the division. The inclusion of all teachers in the department is the result of the consultation and orientation to the teachers concerned and school officials prior to the conduct of this study. It was requested by the teacher-participants that all of them be included in just one LS team due to the teacher's level of confidence in implementing LS and some other school-related concerns.

Statistics 11, as one of the core subjects under the K to 12 senior high school program, is being offered to all senior high school students. All teacher-participants are handling the said subject. For the teacher's profile, all teachers are female whose age ranges from 26 to 55 years old. In terms of the number of years of teaching experience, generally, all of them are new in senior high school department but not necessarily new in the teaching profession. All of them had teaching experiences from private schools handling different mathematics subjects in the junior high school. In terms of academic ranking, 6 are with Teacher II position and two 2 with Teacher I position. And in terms of educational attainment and advancement, only 2 teachers have master's degree, 5 teachers have earned M.A. units, and 1 with bachelor's degree. All these teachers are classroom teachers with advisory classes.

Instrument

A researcher-made survey served as the main instrument in gathering data. This instrument is divided into two parts. Part I is the teacher's profile where basic information were asked to be able to characterize the teacher-participants. While part II is consisting of 5 different self-evaluation surveys, namely, Teachers' Engagement Survey (TE-S), Self-Efficacy Survey (SE-S), Content Knowledge Survey (CK-S), Pedagogical Survey (PK-S), and Attitude Towards Teaching Statistics Survey (ATTS).

The TE-S is a survey consisting of 38 statements that are divided into 4 different stages of the LS cycle. Teacher-participants were asked to reflect on their level of engagement in every stage of LS. The 38 statements describe the different activities and expected output in every stage of LS cycle. Teachers were asked to choose from among numbers 1 (as not engaged) to 4 (as very much engaged). On the other hand, the SE-S is a survey consisting of 32 statements. These 32 statements described the different statistical concepts and tasks expected of the subject. In here, teacher-participants were asked to rate their level of confidence in knowing and engaging in the different statistical concepts and skills. It uses a 6-point scale where 1 (no confidence at all) as the lowest and 6 (with complete confidence) as the highest. This survey was patterned after the self-efficacy survey of Dopa Pathirage, Niranji Anuradha Pathirage [14] whose validity and reliability have been established. However, to serve its purpose to the present study, some modifications were made.

For CK-S and PK-S, a total of 23 statements were utilized. The said surveys are patterned after the three existing and validated surveys on content and pedagogical knowledge [15]– [17]. Again, modifications were made to capture what is intended by the present study. These surveys used a 5-point Likert scale where 5 indicates having complete knowledge and 1 indicates otherwise. Finally, the ATTS is composed of 24 statements. These statements described the teacher's disposition towards Statistics, including teaching and learning Statistics. It also utilized a 5-point Likert scale where 5 indicating strong and positive attitude on the indicated statement while 1 indicating otherwise.

For comprehensiveness and further understanding of the teachers' responses in the surveys, FGD, classroom observation, and reflection logs were conducted and collected. A set of validated guide questions, consisting of 8 general questions, was utilized. These 8 questions were used to obtain responses on the following pre-determined themes: (1) teachers learning experiences in LS process; (2) teacher's level of engagement in LS process/cycle; (3) LS as means of improving teacher's self-efficacy, content, pedagogical and technological

knowledge, and attitude towards teaching Statistics; and (4) LS as teacher's professional development model. The FGD was video recorded to check the facial expressions/reactions and body language of the teachers. Results of interview and FGD were consolidated, transcribed and interpreted for triangulation.

Performance indicator checklist was utilized during classroom observation outside the LS implementation to determine the effect of the teacher's engagement in LS to their everyday teaching. And finally, reflection logs and entries were also requested from the teacher-participants every after lesson implementation. These entries were consolidated, analyzed and interpreted in determining the effect of LS implementation along the teachers' self-efficacy, content knowledge, pedagogical knowledge, and attitude towards teaching and learning Statistics.

Three jurors were requested to validate the said instrument. These jurors are experts in the field of Mathematics education and research. The first juror is a research coordinator of one state university in the province with expertise in Mathematics Education. The second juror is a seasoned mathematics teacher and currently works as the head teacher (HT VI) in the Junior High School Mathematics department of the school where the study was conducted. And the third juror is the Education Program Supervisor (EPS II) in Mathematics of the Division of City Schools, Naga City. It is worth mentioning that the third juror is a practitioner of LS and acted as the LS facilitator in the conduct of the present study. He was responsible in the monitoring of all LS-related activities of the division.

All the suggestions and recommendations were consolidated to arrive at the present survey instruments. Some of the major recommendations and comments were: (1) make each statement more specific; (2) integrate or align the statements to the existing indicators of Results-based Performance Management System for Deped (RPMS); (3) identify and distribute the statements along the different parts of the lesson under before the lesson, during the lesson, and after the lesson; and (4) the statements included in the performance indicator checklist and self-evaluation surveys along content knowledge, pedagogical knowledge, and technological knowledge should be parallel. All these suggestions were carried out and carefully integrated in the revision of the final research instruments.

Data Gathering Procedure

The study utilized multiple data sources. To analyze the multiple sources of data, data were interpreted in chronological order. During the LS implementations, video recordings of RL implementations, observer's checklist and form in the lesson guidelines, LS learner's conversation form, and the minutes of the meetings during the post-lesson discussion and reflection were used and analyzed. These data sources were concurrently gathered, interpreted and analyzed since these sources were collected simultaneously.

The next data sources utilized were the results of self-evaluation surveys, FGD, classroom observation and reflection entries of the teachers. Prior to the conduct of FGD, classroom observation and administration of surveys, letter of request was given to the school principal seeking for the approval of the said activities. The approved letter was, then, given to the assistant principal, track/strand head, and the teachers themselves informing them of the said activities and scheduled date.

Towards the latter part of the study, the self-evaluation surveys were administered. Teachers were gathered in one room and were instructed how to accomplish the surveys. For teachers who were absent, copies of the said surveys were sent or placed on their table and were collected the next day. In the afternoon, FGD was conducted. The minutes and video recordings were transcribed and interpreted. The main objective of the said FGD is to determine the effect of LS to the teachers, how LS impacted their self-efficacy, content knowledge, pedagogical knowledge and attitude in teaching Statistics. In this part, a series of questions were asked to determine the teachers' general impression of LS, including their perception of LS as one possible teacher professional development program in school. It also aims to determine how LS affects their view of their capabilities in teaching and learning Statistics. Results from these were used to validate and compare initial results gathered from the first set of data sources and surveys.

For classroom observation, the teacher-participants were asked regarding their preferred schedule. The performance indicator checklist validated by the jurors was used. Originally, classroom observation is to be conducted by an observer together with the Master Teacher, Assistant Principal, and/or Head Teacher in Mathematics. However, due to unavoidable circumstances during the scheduled dates of observation, the assigned supervisors were not available due to equally important tasks assigned by the division office to them. Thus, with the consent of the teacher-participant and approval of supervisors, the researcher decided to push through with the said classroom observation. These observations were followed with a post-conference

interview using the performance indicator checklist as the basis. Also, reflective entries were requested from every teacher-participant. Results of these observations, interview, and reflective entries were tabulated, coded, analyzed, and interpreted.

Ethical Consideration

Prior to the conduct of this study, letter of request was given to the School Division Superintendent (SDS) to seek approval to conduct the study. The same letter of request, with the approved letter from the SDS office, was sent to the principal, assistant principal, and head teacher of mathematics department of the target school. The rationale and objectives of the study were explained during the Reorientation Seminar on Lesson Study. In attendance were the head teacher of mathematics department, junior high school master teachers, and all mathematics teachers of the school. In that seminar, some parameters and guidelines were drafted for smooth implementation of LS. It was made clear to the teacher-participants that the entire processes and procedures will be recorded through photographs, voice recording and even video recording. However, confidentiality and ethics in doing research study were highlighted and assured in the conduct of the study. The results and performances of the teacher-participants in the conduct of LS will be treated with utmost confidentiality and, in no way, will affect their performance rating as teacher. The teachers were assigned as Teachers A, B, C, D, E, F, G, and H and these names were used to describe the teachers' involvement or engagement in all activities.

Data Analysis

In determining the level and nature of teacher's engagement across the stages of LS, the data collected were analyzed and interpreted descriptively using percentage and frequency count. On the other hand, to determine the relationship between the teacher's level of engagement in LS and the teacher's self-efficacy, attitude, content knowledge, and pedagogical knowledge, the Spearman's rho correlation coefficient was used. Spearman's rho coefficient is a non-parametric test that measures the strength and direction of association between two ranked variables.

Since multiple sources of data were utilized in this study, responses on these sources were tallied and compared. Triangulation technique was utilized to validate teacher's responses on the different themes identified. Triangulation facilitates validation of data through cross verification from more than two sources or by using more than one approach **[18]**. Through this, it can minimize biases and provide deeper understanding of an investigated phenomenon [19]. For this study, data source triangulation was used. Data triangulation, as defined, is a type of triangulation technique where several options were used to gather data such as interviews, observation, questionnaire, and documents [20].

RESULTS AND DISCUSSION

Lessons that can be developed in Lesson Study

LS is a school-based, teacher-led continuing development model that originated in Japan since 1800s. The main idea of LS is simple, if one wants to improve classroom instruction, there is no other obvious and practical step to take but to collaborate with fellow teachers in planning, presenting, observing, and reflecting on the lesson. The core activity of LS is for teachers to collaboratively work on a small number topics or discrete lesson called research lesson (RL). In here, the primary objective of the teachers is to carefully explore and examine how students think and learn. Producing a "splendid" learning or lesson plan is just a by-product of LS. In this present study, two RLs were developed.

The First Research Lesson

The first research lesson (RL1) was about correlation. It was dubbed as *#relationshipgoals*. Under RL1, the goal was for the students to develop the concept of correlation and find ways in determining the kinds of relationship between two quantities. It aims to investigate how students will develop the concept of correlation and the different approaches/methods in determining the correlation coefficient. The team viewed this lesson as vital because of its practical applications in the conduct of practical research which is one expected output among senior high school students. It is also worth mentioning that this lesson is placed at the last part of the Statistics curriculum and commonly is not covered due to time constraints. Thus, the lesson is considered as "least learned lesson" and brings a "big gap" in the actual conduct of research.

Despite the two training-workshops conducted by the researcher and in collaboration with the Division of City Schools under the supervision of the Education Program Specialist (EPS) in Mathematics, the first teaching demonstration of RL1 was deemed problematic. Despite the fact that RL1 was introduced to a group of STEM students, the target objectives were not achieved. And the main cause of this problem was due to the fact that "kyozaikenkyu" was not done properly. There was

no clear research theme, unit goal and identified research problem. The learning plan was solely designed and developed by the assigned teacher-implementer which is contrary to the real essence of kyozaikenkyu. Thus, after the first demonstration fro RL1, the team decided to reexamine and follow kyozaikenkyu and make a better version of the learning plan by incorporating all the suggestions and points raised for consideration during the post-lesson discussion.

The newly created and improved learning plan for RL1 was delivered to another group of students. These students were from one of the General Academic Track sections and are currently being handled by the new assigned teacher-implementer. For the second demonstration of the enhanced RL1, a university professor and chairperson of the Mathematics department, was invited and served as the resource person. She is considered as expert in both research and mathematics education.

During this second demonstration, there was a significant improvement observed in the way the lesson was presented. Students were more active and participative in the activities. And during the interview to some "case students," the students shared that they enjoyed the lesson not only because it was presented clearly but also because of the activities that gave them the opportunity to interact and collaborate, not only with their teacher, but also with their classmates. With the positive responses from the students, the target objectives for RL1 were achieved. Thus, with few suggestions and upon the recommendation of the resource person, RL1 was considered as very satisfactory.

The Second Research Lesson

For the second wave of LS implementation, the team identified the lesson on normal distribution curve as the second research lesson (RL2). One major consideration in selecting the lesson, as reported by the teacher-participants, is because it was observed that in the previous year, the students had difficulty in understanding the concepts of estimation and hypothesis testing. Furthermore, the said topic was identified as an important knowledge and skill in understanding inferential statistics and data analysis. The teacher-participants figured out that a solid foundation in normal curve would help students better understand the succeeding lessons in Statistics. Thus, they considered this lesson as "big gap" in studying Statistics.

Under RL2, the main objective was for the students to come up with a procedure in computing for the area of the region bounded by the normal curve. That is on how to find the area to the right side of the given z-score (or raw score), between two z-scores (or raw scores), and extending to the concept of probability. It also aims to integrate the use of technology in the instruction which, based on studies, plays a crucial role in an effective teaching and learning of Mathematics [7], [15], [21], [22]. Technology integration was done with the use of TI-84 Plus calculator. RL2 was dubbed as *#areaundercurve*.

While the team was preparing and developing the learning plan for RL2, the Division of City Schools scheduled another seminar-workshop in LS implementation. This is to further equip other teachers and intensify the implementation of LS in the entire division. This seminar-workshop was conducted in collaboration with UPNISMED. Having conducted one full LS implementation, the team was instructed by the Division of City Schools to implement the first teaching demonstration for RL2 in the said seminar-workshop. Thus, the designed and developed learning plan for RL2 was first carried out to another group of STEM students on the said seminar-workshop.

Despite the impressive performance in the delivery of the lesson by the teacher-implementer and commendable remarks from the resource-person from UPNISMED, the team agreed to further examine the effectiveness of the designed plan to another group of students who are not in academic track. Carrying out some of the suggestions and recommendations during the first demonstration, the second implementation of RL2 was carried out to one Sports Track class of the school. With parallel results and observations, the team considered the implementation and the designed plan as very satisfactory.

Nature and level of teacher's engagement in the different stages of LS

Part of this present study is to examine the nature and level of engagement of the teachers in the different stages and activities of LS cycle. A typical LS cycle has four stages, namely: (1) goal setting & planning; (2) teaching & observing; (3) post-lesson discussion & debriefing; and (4) re-teaching & reflecting [23]. It is believed that the success and effect of any professional development program such as LS are related to the nature of engagement that the teacher-participants showed.

Different authors would suggest different numbers of members in forming one LS team [23]-[25]. Others would suggest 3 members while others would suggest at 6 members. What is common and apparent in all these

variations is that every team should be composed of a manageable number of teachers who are teaching the same grade level, who are teaching the same subject, or who share the same field of interest. Every team is guided by the so called "knowledgeable other" and/or a resource person who is considered an expert in research or in the subject—Mathematics.

In this present study, upon the request of the teacher-participants and approval of the LS facilitator, only one team was created. All of the 8 mathematics teachers in the senior high school department of the target school were part of the team. As stated earlier, the major considerations in forming the team were the little background of teacher-participants in conducting LS and ease in monitoring on the part of the researcher.

The nature and level of teachers' engagement in the different LS cycles were determined mainly with the use of the TE-S. It is a self-evaluation survey consisting of the different activities and expected outputs in every stage. Based on the survey, the teachers obtained the highest mean score of 2.63 in Teaching & Observing stage. This was interpreted as "very much engaged in collaboration." This was followed closely by Post-Lesson Discussion & Debriefing with the corresponding mean score of 2.56 and Re-teaching & Reflecting with 2.34 mean score. These mean scores were both interpreted as "engaged in collaboration." On the other hand, the teachers got the lowest mean score in Goal Setting & Planning with 2.19 and was interpreted as "somewhat engaged in collaboration."

Several factors were considered in explaining these results. Based on the interviews, observations, and focus group discussions, the following were identified as the main reasons affecting teacher's nature and level of engagement. First, the level of engagement of teachers was affected by the kind of work schedule given to them. It is important to point out that this study was conducted towards the end of the first semester and lasted up to the first quarter of the second semester. Thus, the work schedules of the teachers at the start of the implementation have changed towards the end of this study.

Being one of the largest public high schools in the area, shifting of classes is a common practice. This is a common practice among most of the public schools with large number of enrollees but with insufficient number of classrooms. Some teacher-participants were given a morning shift while others were assigned in the afternoon shift. Finding a common time for teachers in engaging in the different LS-related activities became a big concern in the entire duration of this study. This is apparent in Goal Setting & Planning and Re-teaching & Reflecting stages where the level of teachers' engagement are relatively low where teachers are expected to meet on their own and perform the designated activities and produce the expected outcome in preparing, brainstorming, designing, developing, and re-examining the learning plans and materials. While for Teaching & Observing and Post-Lesson Discussion & Debriefing stages, the level of engagement of teachers were found to be relatively high. This was attributed to the fact that these stages were usually conducted inside the regular Learning Action Cell (LAC) meetings which were part of the regular work schedule of all the teachers. Thus, attendance of all teacher-participants, in the first place, was really expected.

The second factor affecting the level of engagement of the teachers is the presence of an "authority." In this case, the level and the nature of engagement is attributed to the presence or absence of the knowledgeable other, who happened to be the EPS in mathematics of the division office and the LS facilitator. It was observed that teachers were highly engaged and were participative on activities that were initiated or presided by the LS facilitator and knowledgeable other. As mentioned earlier, the two stages—Teaching & Observing and Post-Lesson Discussion & Debriefing—were conducted inside the LAC meetings of the department which were usually being attended by the LS facilitator and knowledgeable other.

Finally, another glaring variable that affects the nature and level of engagement of the teacher-participants was attributed to the kind of attitude that teachers have towards professional development activities. During the focus group discussion and interviews, it was revealed by two teacher-participants that at first they had a negative attitude towards LS. They described their participation as a mere compliance. In addition, the teachers viewed the activity as an additional "burden" to their already hectic workload.

On the other hand, it is worth mentioning that there were some teachers who showed a commendable dedication and consistent interest in the entire duration of LS implementation. These teachers showed positive attitude towards all activities and diligently participated and produced expected outcome in every stage. Thus, it can be inferred that attitude is one important factor to consider in creating professional development program [26]. This implies that having the right attitude means to look at professional development activities as opportunities to grow and learn despite the difficulties and obstacles.

Effects of Teachers' Engagement to Lesson Study

Self-efficacy

Spearman's rho correlation coefficient was used to assess the relationship between the teacher's level of engagement and perceived self-efficacy of teachers in teaching and learning Statistics. Table 1 revealed that there was a positive and moderate correlation between the level of teachers' engagement across stages of LS and the perceived self-efficacy, $r_s = 0.59404$, $n = 8$, p (2-tailed) = 0.12047. This positive moderate correlation indicates that as one variable increases, the other variable also increases. Although the degree of relationship between these two variables is just moderate.

Table 1. Correlation of Teacher's Engagement and Self-Efficacy

		Engage-ment	Self-Efficacy
Engage-ment	Correlation Coefficient	1.000	.594
	Sig. (2-tailed)		.120
	N	8	8
Self-Efficacy	Correlation Coefficient	.594	1.000
	Sig. (2-tailed)	.120	
	N	8	8

This positive and moderate correlation can be attributed to the collaborative nature of LS. Collaboration is one important principle in considering and designing a continuous professional development program. The teacher's participation in the different activities across the stages of LS gave teachers an additional knowledge and strategies in teaching Statistics. For some, these will give them opportunity to share their knowledge in teaching Statistics while others are learning from these shared information. These experiences gave the teachers the sense of approval or a sense of fulfilment which helps improve the level of self-efficacy of the teachers.

Based on the results of FGD and reflection entries, all teacher-participants manifested that LS brought a positive impact on their self-efficacy. According to one teacher, her participation in LS helped her understand some Statistical concepts in a deeper level. Upon a closer look on the reflection entries, it can be noted that teachers attributed the positive impact on their self-efficacy from the acquisition of additional knowledge, both in content and pedagogy, in teaching Statistics. The acquisition of new knowledge gave them more confidence in teaching the subject. With high level of self-efficacy, teachers are expected to be more productive, feel more competent, gain more confidence, and eventually become more successful in their teaching endeavors [27]-[28].

However, the result of the SE-S revealed a slightly different outcome. The SE-S reveals that the teachers got an overall mean score of 4.04 and interpreted as "moderately confident." This moderate level of confidence in teaching and learning Statistics can be attributed to the level of mastery of the teachers in the different Statistical concepts and skills. Looking closely in the survey, the teachers got the highest mean score of 4.88 in statement *"I can identify when the mean, median, and mode should be used as a measure of central tendency."* While the teachers got the lowest mean score of 3.38 on statements *"I can distinguish between statistical significance and practical significance."* and *"I can interpret results of a statistical analysis."* These results are indication that the teachers can fairly perform the different statistical tasks. This could be explained by the profile of the teachers who are, generally, considerably young in teaching Statistics and with less exposure to the application of Statistics.

Attitude towards Teaching Statistics

All teacher-participants claimed that LS brought great impact to their attitude in teaching and learning Statistics. However, upon review and analysis of the reflection entries, the researcher cannot see enough evidence to support this claim. Such claim will only be made possible when the teachers are fully engaged in the entire process of LS implementation. As stated earlier, the teachers were described as less engaged in collaboration on some stages of the LS cycle. And this interpretation is further supported when the correlation coefficient was computed. Table 2 also reveals a positive and moderate relationship between the level of teachers' engagement and attitude, $r_s = 0.448856$, $n = 8$, p (2-tailed) = 0.26495. Again, the positive and moderate correlation means that the two variables are moving in the same direction and the degree of relationship is just moderate.

Table 2. Correlation of Teacher's Engagement and Attitude Towards Statistics

		Engage-ment	Attitude
Engage-ment	Correlation Coefficient	1.000	.448
	Sig. (2-tailed)		.264
	N	8	8
Attitude	Correlation Coefficient	.448	1.000
	Sig. (2-tailed)	.264	
	N	8	8

The moderate correlation between the level of engagement and attitude may be attributed to the prior

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attitude that the teachers possess even before the conduct of LS. A parallel finding was obtained when ATTS was examined. In here, the teachers got an overall mean score of 4.35 and interpreted as having "positive" attitude. The positive attitude can be attributed on how teachers view Statistics as a subject. The survey also revealed some important characteristics of the teachers. The teachers got the lowest mean score of 3.50 in item 15. This item pertains to the teacher's personal activity in line with professional development which states, *"I read different researches and literatures on how a particular lesson in Statistics can be effectively delivered."* This indicates that the teachers are not giving much emphasis or are not engaging so much on professional reading particularly on the recent studies and researches on how one can deliver the lesson in Statistics effectively. This is an affirmation of the findings stated earlier that the teachers handling Statistics in SHS are somewhat experiencing difficulty in terms of the content of Statistics.

Content Knowledge (CK)

Along content knowledge, the CK-S showed that the over-all mean score was 3.13 and interpreted as "I have moderate knowledge." The moderate content knowledge of teachers can be interpreted as the teachers, in general, possess just enough content knowledge of the subject. This result is consistent with the previous findings and interpretation. The moderate knowledge of the teachers may also be an effect to the lack of or insufficient content-based trainings of the teachers handling the subject considering the wide range of topics in Statistics 11.

When the correlation coefficient was computed, the correlation coefficient revealed that there was a positive and moderate correlation between the level of teachers' engagement across stages of LS and perceived content knowledge of the teachers, $r_s = 0.512$, n = 8, p (2-tailed) = 0.194. And just like the previous two interpretations, the positive moderate correlation indicates that these two variables are moving in the same direction but with moderate degree of relationship.

The moderate positive correlation can be attributed to the learning experiences the teachers acquire in the process of "kyozaikenkyu." The meticulous investigation, discussion, and other shared information of the teacher-participants regarding a research lesson gave them another perspective in looking at the lesson. Thus, in effect, teachers got a deeper understanding of the Statistical topic being studied. This interpretation was further supported by the result of the FGD and reflection entries of the teachers. In particular, one teacher admitted during the FGD that one thing she liked most in her participation in LS was the opportunity she was getting in terms of further developing her knowledge on a particular topic or concept in Statistics. This was further supported by the reflection entries where 7 out of 8 teachers specifically pointed out kyozaikenkyu as one aspect of LS they learned the most. Thus, the perceived increase in the teacher's content knowledge is mainly associated to kyozaikenyu. This finding is similar to the findings of other studies on LS [7], [29].

Pedagogical Knowledge (PK)

The PK-S revealed that the overall mean score was 3.22 and described the teachers as having "moderate knowledge." This result can be interpreted as the teachers having just enough knowledge in terms of their general pedagogy. This can also be attributed to the insufficient trainings and opportunities for teachers to learn new trends and innovative ways of delivering the lesson in Statistics. The type of delivery that puts the students at the center of the learning process while concepts and skills in Statistics are being developed.

Further analysis revealed that the correlation coefficient revealed that there was weak, although positive, correlation between the teacher's engagement across stages of LS cycle and the teacher's pedagogical knowledge, $r_s = 0.344$, n = 8, p (2-tailed) = 0.405. The positive but weak correlation indicates that while teacher's engagement and pedagogical knowledge tend to move in the same direction but the degree of relationship between these variables is weak.

Table 3. Correlation of Teacher's Engagement and Content Knowledge

		Engage-ment	CK
Engage-ment	Correlation Coefficient	1.000	.512
	Sig. (2-tailed)		.194
	N	8	8
CK	Correlation Coefficient	.512	1.000
	Sig. (2-tailed)	.194	
	N	8	8

Table 4. Correlation of Teacher's Engagement and Pedagogical Knowledge

		Engage-ment	PK
Engage-ment	Correlation Coefficient	1.000	.344
	Sig. (2-tailed)		.405
	N	8	8
CK	Correlation Coefficient	.344	1.000
	Sig. (2-tailed)	.405	
	N	8	8

Looking at the reflection entries of the teachers along pedagogical knowledge tells a different story. Generally, majority of the teachers wrote that their involvement to LS brought a positive impact, as well as to their pedagogical knowledge. In particular, one teacher shared that among the components included in the study, LS has the greatest impact in her pedagogical knowledge. She claimed that LS helped her realize how a certain concept can be developed and transformed into meaningful learning experience for the student. It is worth mentioning that this was the first teacher-implementer. The improvement on the teachers' pedagogical knowledge is attributed to the collaborative nature of LS in all aspects of designing and developing a lesson. Part of the kyozaikenkyu process is considering also possible teaching strategies and approaches on how to effectively deliver the lesson. In here, the way students think and react is being considered. This perceived enhancement in the pedagogical knowledge of the teachers is similar to the previous studies [7], [30], [31].

CONCLUSION AND RECOMMENDATION

Two lessons were developed using LS cycle. The selection of the topics was greatly influenced by the research theme, research goal, and research problem. The 2 lessons were identified as the "least learned lessons" and/or "big gap" in Statistics 11. While the nature and level of engagement of teachers were characterized to be with less collaboration and were partially engaged. The low level of collaboration and inability of the teachers to fully engage in LS-related activities was attributed to the absence of common free time or "protected time" due to the shifting work schedule and large number of students in the school. The involvement of school heads or officials was found to be another contributing factor affecting teacher's level and nature of engagement. Based on the findings, the teacher's participation to LS was found to have positive yet moderate effect to the teachers' self-efficacy, content knowledge, pedagogical knowledge, and attitude towards teaching and learning Statistics.

It is recommended that in conducting any professional development program for teachers such as LS, emphasis should be placed in the "what," "how," and "why" during the initial stage of the program. Further study may be conducted to explore deeper the process of "kyozaikenkyu." It is also recommended that LS-related activities should be monitored and evaluated by school authority. Equal importance and priority should be given to any professional development programs and create a development and implementation plan that can be incorporated in the school's calendar of activities to avoid conflict and guarantee smooth flow of the activities. Regular and continuous engagement in professional development program accompanied by different content-based trainings and workshops across the strands of Mathematics should also be practiced. This can be done during the regular Learning Action Cell (LAC) session and in partnership with the other learning institutions such as colleges and universities. And finally, further study on teachers' professional development framework may be conducted covering all secondary schools in the entire division that had implemented LS the previous year. Furthermore, developing and validating new research instrument in determining the effect of LS in enhancing teacher's quality may be considered.

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