AN INVESTIGATION INTO THE EFFECTIVENESS OF THE INQUIRY-BASED COOPERATIVE LEARNING MODEL IN TEACHING HIGH SCHOOL CHEMISTRY

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Abstract

The main purpose of this study is to investigate the effectiveness of the inquiry-based cooperative learning model in teaching high school chemistry. The explanatory sequential design, one of the basic mixed method research designs was used in this study. the nonequivalent control group design was adopted for the quantitative study and the case study design was utilized for qualitative study. A total of (315) Grade Ten chemistry students in 2022-2023 Academic Year participated for this study and the intact two classes from each selected school were randomly assigned as experimental group and control group. The experimental groups received instruction with the inquiry-based cooperative learning model and the control groups received formal instruction. The pretest, posttest and students' attitude questionnaire were applied to collect quantitative data. In analyzing quantitative data, analysis of covariance (ANCOVA), Friedman Test and descriptive statistics were adopted. The observation checklist for teachers and interviews with the students and teachers were used for acquiring the qualitative data. The observation data were analyzed with descriptive statistics and the thematic analysis was applied for the interview data. Quantitative findings showed that the students from experimental groups exhibited better chemistry achievement than the students from control groups in all selected schools. There were improvements in the inquiry and cooperative learning skills of the students from experimental groups. Qualitative findings revealed that the teachers from experimental groups successfully implemented their teaching chemistry with inquiry-based cooperative learning model. The students and teachers exhibited positive and favourable attitudes in their teaching-learning processes with the inquiry-based cooperative learning model. Therefore, the inquiry-based cooperative learning model effectively contributed to the teaching of high school chemistry.

Keywords: Inquiry-based learning, cooperative learning, model, chemistry, inquiry-based cooperative learning

Introduction

Education must be concerned with developing the skills and attributes that will promote self-discipline, responsibility, self-expression and confidence. Classroom teaching and learning involve the interaction among teachers, pupils and the curriculum. In order to improve the effectiveness of students' learning, the teacher has to understand the ways in which an individual learns. Learning involves the integration of thinking, feeling, perceiving and behaving. According to Khin Zaw (2001a), through thought man can not only make some sound predictions of what the future is to bring but he can cope with new. That is why, the students' thinking ability should be emphasized in teaching science and so learning science is effective only when it develops rational thinking and learning abilities which form the basis of modern life.

Chemistry plays a major role in science education. Chemistry can prepare students to become scientifically literate citizens by equipping them with skills and understanding that are relevant and meaningful in their daily lives. Therefore, the teachers who teach science or chemistry at the basic education high school level must keenly strive to improve the quality of instruction and methodology in their teaching-learning processes.

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For effective chemistry teaching, the inquiry-based cooperative learning tends to ensure that each student actively engages in the instructional processes and achieves his or her quality learning, through social interaction with content of study; by critical reasoning; through discussions and exchange of ideas. The inquiry-based cooperative learning model will scaffold learning activities that support students' conceptual understanding. By applying this instructional model in teaching chemistry, the students can be mostly engaged in the instructional procedures, strengthened their scientific literacy and improved their self-confidence in learning chemistry.

Research Purpose

The main purpose of this study is to investigate the effectiveness of the inquiry-based cooperative learning model in teaching high school chemistry. The specific objectives are as follows:

1. to develop an inquiry-based cooperative learning model in teaching chemistry at the high school level.
2. to investigate the effects of the proposed model in teaching chemistry at the high school level.
3. to explore the attitude of students towards learning through inquiry-based cooperative learning model and that of teachers towards teaching through it.
4. to give suggestions for the improvement of high school chemistry teaching based on the results of the study.

Research Hypotheses

The research hypotheses of the study are described as follows:

H1: The chemistry students who receive learning with the inquiry-based cooperative learning model exhibit better achievement than those who do not.

H2: The chemistry students who receive learning with the inquiry-based cooperative learning model improve their inquiry and cooperative learning skills in their group work.

H3: The students who are taught with the inquiry-based cooperative learning model may have positive attitudes towards learning high school chemistry.

H4: The teachers who employ the inquiry-based cooperative learning model may have positive attitudes towards teaching high school chemistry.

Definition of Key Terms

The key terms of the study were described as follows:

Inquiry-based learning: Inquiry-based learning is a process where students formulate questions, investigate widely and then build new understandings, meanings and knowledge (Branch & Oberg, 2004).

Cooperative learning: Cooperative learning is a teaching strategy that organizes students to work together in small teams so that everyone can participate in a clearly assigned task or role which contributes to the leaning of each member of the team and to the team as a whole (Kivunja, 2015).

Model: A model of teaching is a plan or pattern that can be used to design instructional materials and to guide instruction in the classroom and other settings (Joyce & Weil, 1980).

Chemistry: Chemistry is the study of the interactions of matter with other matter and with energy (Ball, 2011).

Operational Definition of the Study

Inquiry-based Cooperative Learning: Inquiry-based cooperative learning means an instructional strategy that organizes students to work together in small groups who actively engage in inquiry-based learning processes and then finally attain the desired learning outcomes.

Scope of the Research

This study is geographically restricted to Mandalay Region and Nay Pyi Taw Union Territory. For this study, the participants from the selected high schools were Grade Ten chemistry students and teachers in 2022-2023 Academic Year. This study deals with the methodology of high school chemistry teaching in Myanmar.

Review of Related Literature

Inquiry-based Cooperative Learning Model

The inquiry-based cooperative learning model is based mainly on the ideology of three educational philosophies: pragmatism, progressivism and constructivism. Furthermore, learning theoretical considerations of cognitive learning theory, cognitive development and constructivist theory, sociocultural theory social cognitive theory, taxonomy of learning and cybernetic perspectives are especially taken into account for the proposed model. There are five main components in this instructional model and the detailed descriptions of the proposed model are presented as follows.

I. Preparing Instruction

The following four steps for preparing instruction are included.

(a) Selecting content: The teacher selects the content that are mostly matched with the inquiry-based cooperative learning from Grade Ten chemistry textbook in 2021-2022 Academic Year.

(b) Identifying learning objectives: The learning objectives are described by applying the precise and observable behavior for each segment of instruction. The achievement of the learning objectives can be measured from the students' behavior through their inquiry-based cooperative learning activities and their achievement scores.

(c) Determining entering behavior: The purpose of this stage is to determine the students' entering behavior for organizing them into groups and prerequisite skills for the instruction. The students' background knowledge is interpreted by using the diagnostic assessment.

(d) Choosing instructional materials: The chemistry teacher selects the appropriate instructional materials in accordance with the learning objectives and the instructional model.

II. Organizing Groups

This component includes two steps in which students are managed to their respective groups for more learning cooperatively and communicatively.

(a) Grouping students: The heterogeneous groups of the students are organized in size from (4) to (6) group members by mixing as much as possible based on their academic abilities, gender and background knowledge.

(b) Assigning the different roles and tasks of the students: According to the tasks in their learning groups, the students are assigned including leader, presenter, recorder, observer, checker and timer.

III. Implementing Inquiry-based Cooperative Learning Procedures

There are the following seven steps in this instructional procedure.

(a) Encountering with the problem (or) puzzling situation: The students are introduced to new concepts or problems that are linked with the prior knowledge based on inquiry through questioning, demonstration, discussion, laboratory work and the use of mathematics in accordance with the nature of lesson topics under the monitoring and guidance of the teacher.

(b) Preparing and gathering data: The students and teachers prepare and gather data through some inquiry processes including, questioning and observing to obtain information or data about objects and events; measuring and classifying the collections of objects or events, using numbers for gathering mathematical data; communicating by constructing graphs and diagrams for expressing complex phenomena and inferring based on the observation and assumptions for collecting a bit of information about the objects and events in order to formulate the hypotheses and carry out investigation.

(c) Implementing the group investigations: The students implement the group investigation based on the preparation and gathering necessary data. The group members discuss their work in progress to exchange ideas and information, and to clarify, and integrate them. The teacher allows students to use the various types of experiments, including pencil-and-paper, and concrete experiments to test the hypothesis. They perform their tasks responsibly with the cooperative manner. The included inquiry process skills are formulating and testing hypotheses, predicting data, controlling variables, and experimenting the puzzling situation.

(d) Interpreting and organizing products (or) results: The students interpret their findings individually as well as by discussing with their group members and they also compare their respective findings with their problem. They organize the information they have collected and summarize it. Finally, the group prepares a report that integrates the answers they found.

(e) Presenting and sharing ideas and results: The group members determine the main idea of their investigation. The presenter in their group should clearly express their main ideas and findings. The students feel more confident in this stage.

(f) Applying the ideas and results: This stage can include the inquiry process skills, namely, making operational definition that is the students organize information they obtained during the above activities and try to explain the discrepancy for the selected content.

(g) Reflective process: In this stage, both the teacher and the students reflect on the learning process of the students and their product by discussing and asking the necessary questions to confirm the understanding and conceptualizing of the students for acquiring the main facts, ideas and concepts of chemistry.

IV. Summative Assessment

The teachers assess the students' daily practice by observing the tasks that the students carry out, by looking at what they write and make, and by considering how they respond to ask questions. At the end of the instructional process or of a period of learning, the summative assessment is used to evaluate student learning.

V. Providing Feedback

If the students cannot perform well in the assessment and cannot achieve the learning objectives, they will go to the stage of providing feedback and take the necessary feedback. If they can do well in the inquiry-based cooperative learning procedures and achieve the learning objectives, they will continue to learn the new contents.

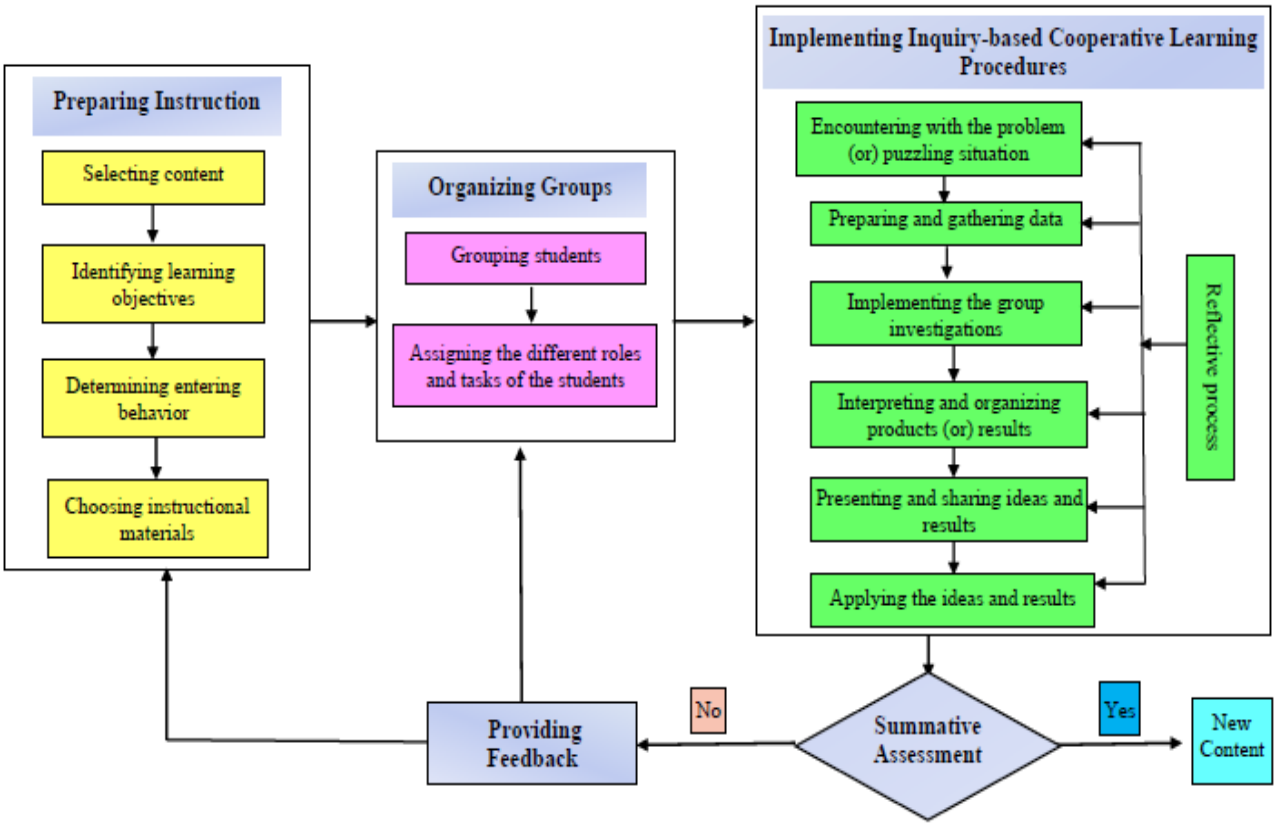

Figure 1. Inquiry-based cooperative learning model for teaching high school chemistry.

Research Method

For implementing the inquiry-based cooperative learning model in teaching Grade Ten chemistry, research design, population and sample, instruments, data analysis and research procedure are discussed as follows.

Research Design

Based on Mills and Gay (2016), the explanatory sequential design (QUAN →qual) was used for this study. In the quantitative study, the nonequivalent control group design was adopted to explore the effectiveness of the inquiry-based cooperative learning model. For qualitative study, the case study design was utilized to know the attitudes and opinions of the students and the teachers who participated in experimental groups.

Population and Sample Size

The intact classes were randomly selected as experimental groups and control groups, and the target sample size were chosen from the selected schools by using simple random sampling method. The selected schools and sample size are described in Table 1.

Table 1 ***Population and Sample Size for Data Collection***

Name of School	No. of Population	No. of Sample		
		Experimental Group	Control Group	Total
• No. (5), Basic Education High School, Chanayetharsan	84	40	30	70
• Basic Education High School, Patheingyi	200	49	40	89
• No. (12), Basic Education High School, Ottarathiri, Nay Pyi Taw	125	35	40	75
• No. (18), Basic Education High School, Dekkhinathiri, Nay Pyi Taw	128	39	42	81
Total	**537**	**163**	**152**	**315**

Research Instruments

For investigating the effectiveness of the inquiry-based cooperative learning model in teaching chemistry, the instruments for quantitative study were pretest, posttest, group work assessment form and students' attitude questionnaire. For the qualitative study, observation checklist for teachers and the interview questions were constructed to know the attitudes and opinions of Grade Ten Chemistry teachers and students from the experimental groups.

Data Analysis

When the required data had been collected, data analysis was carried out. The analysis of covariance (ANCOVA) for the pretest and posttest scores, Friedman test for the group work assessment form, descriptive statistics for questionnaire and observation data, and the thematic analysis for the interview questions of teachers and students were utilized for this study.

Research Procedure

The inquiry-based cooperative learning model was developed and the lesson plans were constructed. The instruments were validated with seven academic and education experts. The pilot study was conducted with (34) Grade Ten chemistry students. The Kuder-Richardson 20 value obtained .85 for the reliability of the pretest. The reliability value of Cronbach's Alpha for the posttest and group work assessment form had .826 and .764. The interobserver or interrater reliability coefficient for observation checklist was obtained .844. The main study was conducted from September 2022 to December 2022. During treatment period, the experimental groups were taught Grade Ten chemistry with the inquiry-based cooperative learning model while control groups were taught with formal instruction.

Observation for the teachers and students' group work assessment from the experimental groups were conducted during the treatment periods. After administering the tests, the students from the experimental groups were requested to answer the attitude questionnaires. The reliability coefficient, Cronbach's Alpha value was .834 for students' attitude questionnaire. Then, the teachers and students from the experimental groups were selected by using random purposive sampling method for one-to-

one interviewing and all interview sessions were recorded. Finally, the collected quantitative and qualitative data were analyzed and interpreted according to the research design.

Findings

The findings of the quantitative and qualitative study are presented as follows.

Findings of Pretest

The data obtained from the pretest were analyzed by using analysis of covariance (ANCOVA*)* to determine whether there were significant differences between the group equivalence of the two selected groups for the selected schools. The results of the pretest for the respective selected schools are described in Table 2.

Table 2 ***Analysis of Covariance (ANCOVA) Results of Pretest in the Selected Schools***

School	Group	*n*	*M*	*SD*	*MD*	*F*	*p*
S1	Experimental	40	34.85	6.070	5.62	14.814	.000***
	Control	30	29.23	6.004			
S2	Experimental	49	34.31	6.703	-0.16	0.013	.911(ns)
	Control	40	34.47	7.476			
S3	Experimental	35	37.23	4.947	4.28	10.446	.002**
	Control	40	32.95	6.316			
S4	Experimental	39	35.31	7.388	-0.21	0.024	.878 (ns)
	Control	42	35.52	5.152			

Note. S1 = No. (5), Basic Education High School, Chanayetharsan; S2 = Basic Education High School, Patheingyi; S3 = No. (12), Basic Education High School, Ottarathiri, Nay Pyi Taw; S4 = No. (18), Basic Education High School, Dekkhinathiri, Nay Pyi Taw.

ns = not significant. ***p* < .01. ****p* < .001.

The results described in Table 2 showed that there were significant differences between group equivalence of the two selected groups in S1 and S3. According to the results of S2 and S4, there were no significant differences between the pretest scores of the experimental group and those of the control group ($p > .05$) because they had the equal chemistry knowledge before treatment.

Findings of Posttest

In order to know whether or not the significant differences in chemistry achievement between the experimental and control groups, the posttest scores were analyzed by applying the analysis of covariance (ANCOVA*)* and the findings are presented as follows.

Table 3 ***Analysis of Covariance (ANCOVA) Results of Overall Posttest Means based on Effect Size for the Selected Schools***

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*MD*	*F*	*p*	*Posttest Partial Eta Squared*	*Pretest Partial Eta Squared*
S1	Experimental	40	38.88	39.15	8.44	31.31	.000** *	.319	.018
	Control	30	31.13	30.71					
S2	Experimental	49	39.51	39.49	19.48	84.68	.000**	.496	.014

School	Group	*n*	Unadjusted Mean	Adjusted Mean	*MD*	*F*	*p*	*Posttest Partial Eta Squared*	*Pretest Partial Eta Squared*
S3	Control	40	20.22	20.01	2.75	12.98	* .001**	.153	.091
	Experimental	35	44.43	44.81					
S4	Control	40	42.40	42.06	4.25	9.69	.003**	.111	.009
	Experimental	39	42.56	42.62					
	Control	42	38.43	38.37					

Note. S1 = No. (5), Basic Education High School, Chanayetharsan; S2 = Basic Education High School, Patheingyi; S3 = No. (12), Basic Education High School, Ottarathiri, Nay Pyi Taw; S4 = No. (18), Basic Education High School, Dekkhinathiri, Nay Pyi Taw.

***p* < .01. ****p* < .001.

According to the obtained data based on Table 3, the comparison of overall posttest means for the selected schools is described in Figure 2.

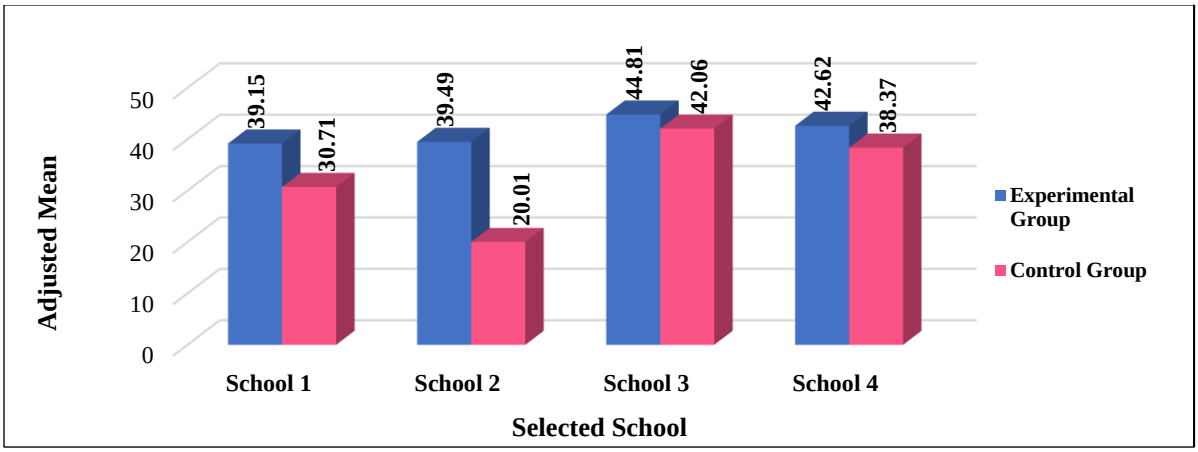

Figure 2. Comparison of overall posttest adjusted means on chemistry achievement in the selected schools.

According to the findings, it can be interpreted that there were no significant influences of pretest scores and other extraneous variables on the posttest scores of the students and Grade Ten chemistry teaching with the proposed model. The use of the inquiry-based cooperative learning model significantly supported the students' critical and judgmental thinking ability for improving their recalling, conceptualizing, applying, classifying and reasoning chemistry contents more than the formal instruction. Therefore, the inquiry-based cooperative learning model had well contribution to chemistry achievement in all selected schools.

Findings of Group Work Assessment

Group work assessment was applied to know the actual performance of the students and measure the improvement of the inquiry and cooperative learning skills of the experimental groups of the selected schools. Therefore, group work assessment was conducted three times at three different time periods (starting intervention (first time), during intervention (second time) and ending intervention (third time)). According to Pallant (2013), Friedman Test was applied to test their improvement.

Table 4 ***Friedman Test Results of Group Work Assessment Form of the Students for Classroom Inquiry and Cooperative Learning Skills***

Skill	Mean Rank			*Md* (Median)			*df*	*Chi-Square* χ^2	*p*
	1st Time (S)	2nd Time (D)	3rd Time (E)	1st Time (S)	2nd Time (D)	3rd Time (E)			
CIS	1.29	2.21	2.50	16	17	17	2	6.87	.032*
CLS	1.43	1.71	2.86	15	17	18	2	8.62	.013*
Overall	1.29	1.86	2.86	31	34	36	2	8.86	.012*

Note. CIS = Classroom Inquiry Skills; CLS = Cooperative Learning Skills. S = Starting Intervention; D = During Intervention; E = Ending Intervention.

*$p < .05$.

Based on the obtained data from the Friedman test results, the following Figure 3 is presented.

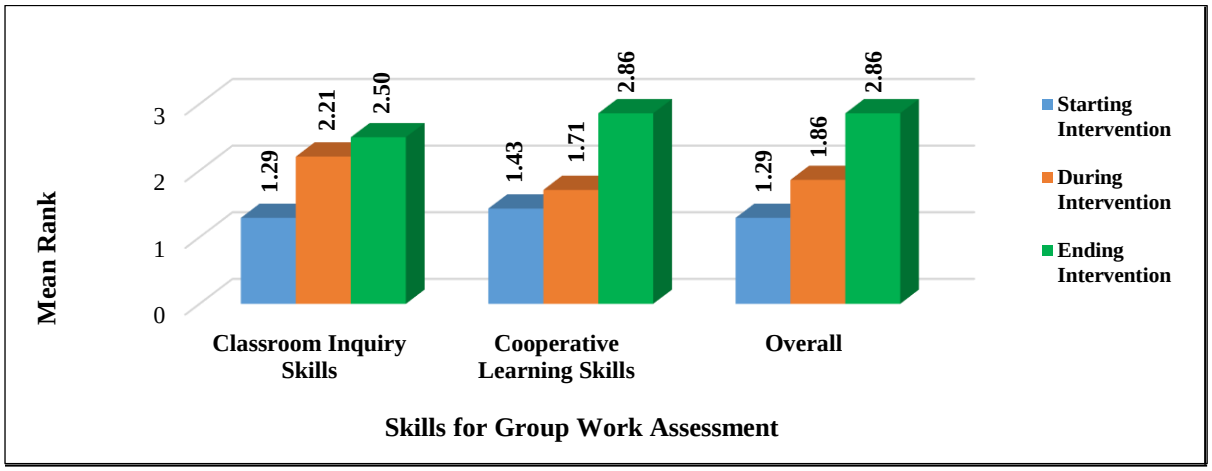

Figure 3. Illustration for comparison of mean rank results of group work assessment form

It was found that the overall results of the Friedman Test indicated that there were statistically significant in group work assessment scores across the three time points χ^2 (2, n = 49) = 8.86, $p < .05$). Additionally, inspection of the median values showed slightly increasing in group scores from the second week of intervention (*Md* = 31) to during intervention (*Md* = 34) and a further increase at the ending of intervention (*Md* = 36). Therefore, it was found that there was improvement in inquiry and cooperative learning skills by comparing the mean ranks and the median values of group work scores after intervention.

Findings of the Attitudes of Grade Ten Chemistry Students

The questionnaire was constructed to explore the attitudes and feelings of Grade Ten Chemistry students who were participated in the experimental groups. The questionnaire was mainly based on the inquiry-based cooperative learning model and some items were adapted from the attitude questionnaires of Kouros and Abrami (2006), and of DiBiase and McDonald (2015). This questionnaire was constructed as Five-point Likert scale from “strongly disagree” to “strongly agree” to indicate the attitudes towards each item.

Table 5 ***Responded Rates of Students' Attitudes towards Learning with the Inquiry-based Cooperative Learning Model***

Statement	*Percentage (%), n = 163*				
	Strongly disagree	**Disagree**	**Undecided**	**Agree**	**Strongly agree**
More understand the nature and the relationships of chemistry.	3.2	1.8	14.7	65.0	15.3
Be able to improve the problem-solving abilities.	1.2	4.3	27.6	49.7	17.2
Be able to promote the practical investigative and interpersonal skills.	4.3	-	20.9	54.6	20.2
Identify the meanings of the lessons themselves from the inquiry-based cooperative learning experiences.	1.8	3.7	24.5	52.8	17.2
Like to improve optimistic attitude.	6.2	3.6	14.7	49.1	26.4
Like to obtain the dutiful habits for conducting the respective responsibility.	5.0	2.4	9.2	49.1	34.3
Enjoy applying the instructional aids and real-objects matched with the chemistry lessons.	3.1	3.7	13.5	47.2	32.5
Like to interactively reflect on the lessons together with teachers.	1.8	3.7	14.1	49.1	31.3
Become self-confident due to sharing information obtained from learning chemistry.	2.4	4.9	15.3	44.8	32.6
Unliked to noisily discuss and talk to each other among the group members.	17.8	14.7	10.4	31.3	25.8
Unliked to share the instructional aids with others.	26.3	25.2	9.2	23.3	16.0
Require a lot of time for sharing and presenting the lessons.	5.6	5.5	10.4	44.8	33.7
Have difficulty participating in reflective discussions together with the teacher.	12.8	25.2	19.1	28.2	14.7
Delay for asking questions concerned with lessons.	12.3	17.8	19.6	33.1	17.2
Unliked to wait for other students who did not understand the lessons.	25.7	17.8	22.7	21.5	12.3

Based on the findings, most of the students from the selected schools expressed that they had merits from learning chemistry through this inquiry-based cooperative learning model because they acquired the scientific inquisitive habits, logical problem-solving manner and self-confidence by sharing the learned materials. On the other hand, some students may be seemed that they have little satisfaction about the conditions of the classroom with this instructional model. However, they became patient in waiting for other academically weak students. The students can gradually acquire such positive attitudes as mutual understanding, empathy and patient among their classmates. It can be interpreted that the attitudes of the students were optimistic towards this instructional model.

Findings of Observation Checklist for Teachers

According to the performance of the teachers, three rating scales were referred to (1) stands for not observed which means that the observer did not observe the described behaviour during the instruction, (2) stands for observed occasionally which means that the observer observed the described behaviour once or twice during the instruction, (3) stands for observed frequently which means that the observer observed the described behaviour more than twice during the instruction. Based on (24) times for total observation, the obtained data were analyzed by using descriptive statistics and the findings are described in Table 6.

Table 6 ***Findings of Observation Checklist for Teachers in Using the Inquiry-based Cooperative Learning Model***

Main Component	**Descriptions of Observed Factors for Teacher**	***Percentage (%)***		
		not observed	**observed occasionally**	**observed frequently**
Preparing Instruction	• Select chapters and topics matched with inquiry-based cooperative learning.	8.3	75.0	16.7
	• Define the learning objectives in terms of precise and observable behavior.	16.7	45.7	37.6
	• Determine the students' different background knowledge, abilities, and the prerequisite skills.	8.3	50.0	41.7
	• Choose the proper instructional materials based on the nature of the content and learning objectives.	12.5	54.2	33.3
Organizing Groups	• Manage the students into heterogeneous groups.	16.7	70.8	12.5
	• Assign the different roles and tasks of the students.	37.5	25.0	37.5
Implementing Inquiry-based Cooperative Learning Procedures	• Introduce new concepts or problems based on inquiry through questioning, demonstration, discussion, laboratory work, and the use of mathematics.	-	83.3	16.7
	• Encourage students to gather data through some inquiry processes including, questioning and observing, measuring and classifying, using numbers for gathering mathematical data; communicating and inferring.	-	54.2	45.8
	• Allow students to use the various types of experiments which include inquiry process skills such as formulating and testing hypotheses, predicting data, controlling variables, and experimenting with the problem.	16.7	50.0	33.3
	• Suggest the students interpret the results in acceptance or rejection of the hypothesis and organize major points of the lesson.	-	29.2	70.8
	• Organize the groups' plans for their presentations and manages the schedule.	8.3	66.7	25.0

Main Component	Descriptions of Observed Factors for Teacher	Percentage (%)		
		not observed	observed occasionally	observed frequently
	• Provide opportunities for students to express their learning with possible actions.	-	50.0	50.0
	• Reflect on the learning process by discussing and asking the necessary questions.	-	62.5	37.5
Summative Assessment	• Assess with the paper and pencil test, and the direct observation of the teacher.	8.4	45.8	45.8
Providing Feedback	• If necessary, the feedback, discussion, and explanation are provided and retaught by the teacher.	25.0	54.2	20.8

Based on the findings of observation checklists, the teachers from the experimental groups successfully conducted their instruction with the inquiry-based cooperative learning model, and the students systematically followed the instructions of the teachers.

Findings of Teachers' Interviews

The data obtained from interview were analyzed by using thematic analysis. Thematic analysis is a type of qualitative analysis. Thematic analysis is the process of identifying patterns or themes within qualitative data (Boyatzis, 1998). The interview data obtained from this qualitative study were analyzed according to the thematic analysis model of Miles and Huberman (1984) in which there were three link stages or 'streams', i.e., data reduction, data display and data conclusion-drawing/verifying. The findings obtained from teachers' interviews are presented in Table 7.

Table7 ***The Emerging Main Theme and Sub-theme from Teachers' Interviews***

Sub-theme	Main Theme
• Preparing Instruction • Nurturing Curiosity and Inquiry • Supporting Conceptual understanding and Cooperative learning • Motivation • Creating Positive Classroom Conditions	Instructional experiences through the implementation of the inquiry-based cooperative leaning model
• Facilitation Skills • Collaboration and Communication Skills • Questioning Techniques • Assessment Strategies • Providing Feedback and Reflection	Pedagogical contributions of the inquiry-based cooperative learning model
• Instructional Time • Instructional Materials • Students' Individual Differences	Challenges for using the inquiry-based cooperative learning model

According to the main theme and sub-theme from teachers' interviews, it can be interpreted that they acquired the experiences of how to nurture the students' curiosity and inquiry habits based on their group investigation activities. Although they had the challenges in

their instruction with this proposed model, they could create positive classroom conditions that could also support the students' 21st century skills, such as collaboration, communication, critical thinking and problem-solving, creativity, innovation and citizenship.

Findings of Students' Interviews

The findings obtained from the students' interviews are presented in Table 8.

Table 8 ***The Emerging Main Theme and Sub-theme from Students' Interviews***

Sub-theme	Main Theme
• Learning activities • Conceptual understanding • Satisfaction • Self-confidence	Experiences through the inquiry-based cooperative learning activities
• Effectiveness for Cognitive Skills • Effectiveness for Inquiry Skills • Effectiveness for Cooperative Learning Skills	Effectiveness of the inquiry-based cooperative learning model
• varying academic abilities • limit their opportunities to engage in practical application • restrict opportunities for them to engage in the learning activities • limit the opportunities for individualized attention and support	Difficulties of using the inquiry-based cooperative learning model

Based on the main theme and sub-theme from students' interviews, it can be interpreted that they had positive attitude towards their learning with this instructional model. Because they learn to appreciate and respect differences and strengthen their interpersonal skills by working with diverse group members from learning chemistry through the inquiry-based cooperative leaning model. They acquired the sense of reflecting the feedback from peers and teachers on their work. Moreover, they agreed that they develop their reflective thinking skills and continuously strive for improvement by engaging in this process.

Discussion and Suggestions

After presenting the findings of the quantitative and qualitative studies, discussion and suggestions of the research are described in this section.

Discussion

The main purpose of this research is to investigate the effectiveness of the inquiry-based cooperative learning model in teaching high school chemistry. The discussion concerns to what extent the instructional model affects on teaching Grade Ten chemistry and what attitudes of the teachers and students are.

Hypothesis (1): The posttest was used to examine the impact of the inquiry-based cooperative learning model on the students' achievement. According to the findings of four selected schools, it was found that there were significant differences between chemistry achievement of the experimental groups and that of the control groups in all selected schools. The inquiry-based cooperative learning model had positive effects on the students' chemistry achievement in all selected schools. These findings are matched with the findings of Adiasti, Soetjipto and

Gipayana (2016) who conducted the implementation of inquiry learning by setting cooperative model type group investigation to enhance the activity and learning outcomes of the students.

Hypothesis (2): The group assessment was employed to measure the improvement of the inquiry and cooperative learning skills of the experimental groups from the selected schools. Based on the results of the Friedman Test of group work assessment form, there were improvements in inquiry and cooperative learning skills by comparing the mean ranks and the median values of group work scores across the three time periods in all selected schools. According to the findings from the group work assessment, the inquiry-based cooperative learning model can have a positive impact on the improvement of the students' inquiry and cooperative learning skills which take a vital role in their daily life situations and can support the increase of their 21st century skills.

Hypothesis (3): To know to what extent the qualitative findings explain and support the quantitative findings, the students' attitudes towards their learning chemistry through the inquiry-based cooperative learning model were explored by using the questionnaire survey and interview questions. The students were interested in chemistry subject by learning with inquiry-based cooperative learning model. Sometimes they struggled with adjusting to one another due to individual differences, available instructional time and resources. However, the inquiry-based cooperative learning model has a positive impact on their conceptual understanding or cognitive skills, inquiry and cooperative learning skills. They were able to develop their interpersonal skills and learn to recognize and value diversity. They had favourable attitudes about their leaning with inquiry-based cooperative learning model. These findings are in line with the results of Bilgin (2009) who studied that the effects of guided inquiry instruction incorporating a cooperative learning approach on university students' achievement of acid and bases concepts and attitude toward guided inquiry instruction.

Hypothesis (4): In order to know the teachers' attitudes towards their teaching chemistry through the inquiry-based cooperative learning model were discovered by applying observation checklist and interviews. They could scaffold their students for conceptualizing the basic chemistry concepts and give the opportunities and motivation of their students to cooperate in their learning activities. They had challenges concerning the available instructional time, materials and students' individual differences. However, this instruction model positively contributed to their instructional experiences and pedagogical skills. They had positive attitudes about their teaching with inquiry-based cooperative learning model. These findings can underpin and support the quantitative research findings.

Suggestions

For chemistry education to be effective in terms of promoting students' understanding of, and interest in chemistry, highly qualified chemistry teachers are necessary. Every chemistry teacher should encourage students to develop interest and meaningful learning by changing their methods of teaching to enhance the quality of instruction and learning of chemistry. From this view, the inquiry-based cooperative learning model for teaching high school chemistry was developed to support the effective and efficient instruction of chemistry and to actively and intellectually participate the students in their learning process.

To the teacher, the real work required of students is the thinking and learning involved in undertaking a task, and the task is often just a means to support that mental activity. In order to become deep and meaningful learners of chemistry, teachers should implement their instruction together with hands-on and mind-on learning activities to support the mental activities of the students in conceptual understanding of chemistry concepts. The students take a vital role in the teaching–learning process. Therefore, in order to have a sound foundation of chemistry concepts, the students must have an inquisitive mind and, have the learning abilities independently and cooperatively.

Khin Zaw (2001b) pointed out that learning is itself an active process of change; it is the process by which behaviour is developed or altered through practice or experience. Based on this idea, in the inquiry-based cooperative learning model, the students managed to encounter inquiry-based cooperative learning experiences and practices for obtaining the above-mentioned learning abilities and taking place learning chemistry systematically.

Conclusion

Education provides individuals with the opportunity to improve their lives, become successful members of their communities and actively contribute to national socio-economic development. The OECD Future of Education and Skills 2030 project pointed out that in the education sector, some changes are already emerging. The schools aspire to operate with a curriculum that recognizes the need for interdependence and broadens the goals of education to include education for citizenship (Organization for Economic Co-operation and Development, 2019).

In order to match these conditions of the education system, these inquiry-based cooperative learning procedures can prepare both the teachers for teaching activities and the students for learning activities in order to achieve the demands of 21st century skills and be gradually consistent with the requirements of current educational changing views.

Therefore, it is concluded that the inquiry-based cooperative learning model is effective for teaching high school chemistry. The degree and/or level of its effectiveness is of course dependent on the individual teacher’s capacity to optimally control the cycle of classroom learning activities. This in turn points to another responsibility for pedagogues utilizing the inquiry-based cooperative learning model — the professional obligation to observe teacher neutrality. Hence, the researcher would like to conclude with the final surmise that the inquiry-based cooperative learning model will reach maximal effectiveness if and when teachers can exercise optimum class control and appropriate pedagogic neutrality, the two most crucial and/or basic controversies in the long history of modern education.

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