AN INVESTIGATION INTO THE IMPACT OF THE INTEGRATED COLLABORATIVE CONCEPT MAPPING MODEL IN TEACHING PHYSICS

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Abstract

The main purpose of this study is to investigate the impact of using the proposed model based on the integration of collaborative learning techniques and concept mapping in teaching Physics. In this research, embedded design, one of the mixed-method designs was adopted. A quasi-experimental design was used as a quantitative study and a case study design was used as a qualitative study. Instruments like pretest, posttest, questionnaires, self-assessment forms, lesson plans prepared with the proposed model, and worksheets were used as the quantitative instrument. An observation checklist and semi-structured interview questions were used as qualitative instruments. A random sampling method was used to choose four high schools from Yangon Region. The purposive sampling method was applied for collecting qualitative data. Quantitative findings by ANCOVA showed that the Physics achievements of students who were taught with the integrated collaborative concept mapping model were higher than the students who did not receive it. Attitudes questionnaires results by the Wilcoxon Signed Rank Test showed that positive attitudes changes were found by comparing before and post results. Friedman Test results of self-assessment forms showed that the students who participated in experimental groups have improvements in all 5 Cs like collaboration, communication, critical thinking and problem solving, creativity and innovation, and citizenship across three-time points. Qualitative findings revealed that the students and teachers from experimental groups preferred this model, actively participated in the intervention periods, and are willing to apply an integrated collaborative concept mapping model in their teaching process. All the results proved that the integrated collaborative concept mapping model was supportive in teaching Physics concepts included in the new curriculum which aims to acquire soft skills along with teaching subject knowledge.

Keywords: Learning, Collaborative Learning, Concept, Concept Mapping, Collaborative Learning Techniques

Introduction

Education is a purposeful activity to facilitate learning to acquire knowledge, skills, values beliefs, responsibility, and habits. Preparing learners for the world of work is the important goal of education in today world. According to Khin Zaw (2001), the aims of education may be summed up under three aspects: to help the child to develop his personality; to relate himself to the society in which he lives, and to be an active and creative force in society. Education allows individuals to improve their lives, become successful members of their communities, and actively contribute to national development (National Education Strategic Plan (NESP), 2016-2021). Ideally, science teaches students how to think, learn, solve problems and make informed decisions. Physics is a part of science that deals with describing the interactions of energy, matter, space, and time and it is especially interested in which fundamental mechanisms underlie every phenomenon. One of the aims of teaching Physics in secondary schools is to acquire a systematic body of physical knowledge and develop an understanding of Physics's concepts, principles, and applications. By understanding the concepts and principles, then one can further education in Physics (Maera, 2016). Today's knowledge work is done collaboratively in teams. Concept mapping encourages collaboration among users constructing the maps. In light of the importance of collaboration in teaching and learning situations for the new education curriculum, the study of the impact of integrated collaborative concept mapping should be extended to secondary high school students in Myanmar.

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Purposes of the Study

The main purpose of the study is to investigate into the impact of the integrated collaborative concept mapping model in teaching Physics.

The specific objectives are as follows:

(1) To develop a model based on the integration of collaborative learning techniques and concept mapping
(2) To investigate the impact of using the model based on the integration of collaborative learning techniques and concept mapping on students' achievement in Physics
(3) To compare the attitudes of students towards Physics teaching through collaborative learning techniques and concept mapping
(4) To examine the attitudes of teachers towards using the proposed model in teaching Physics
(5) To explore the students' acquired soft skills along with teaching Physics concepts

Research Hypotheses

1. There is a significant difference in achievement scores between Grade 10 students who are instructed by using the model based on collaborative learning techniques and concept mapping and who are not received it.
2. There is a significant difference in the attitudes of students towards learning Physics who are instructed by using the model based on collaborative learning techniques and concept mapping before and after the intervention.
3. There is a significant difference in the attitudes of teachers towards using the model based on collaborative learning techniques and concept mapping before and after using this model.
4. There are significant changes in the students' acquired soft skills after teaching Physics with the proposed model.

Scope of the study

- This study is geographically restricted to the Yangon region.
- Participants in this study are Grade Ten students from the selected high schools.
- This study is limited to the content areas of forces, pressure, work, and energy from the Grade Ten Physics textbook prescribed by the Basic Education Curriculum, Syllabus, and Textbook Committee, 2020-2021.

Definition of Key Terms

Learning: Learning is a process that leads to change, which occurs as a result of experienced and increases the potential for improved performance and future learning (Ambrose, Bridges, DiPietro, Lovett, & Norman (2010).

Collaborative Learning: Collaborative learning is an umbrella term for a variety of educational approaches involving a joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product (Smith & MacGregor, 1992).

Concept: A concept may be thought of as a mental framework of an event or an object. Any event or object is a concept because it has some identifiable properties or ideas associated with it (NCERT, 2013).

Concept Mapping: Concept mapping is a technique that visually represents relationships among ideas (Novak & Gowin, 1984, cited in Collette & Chiappetta, 1989).

Collaborative Learning Techniques (Operational Definition): Collaborative learning techniques are the techniques used for general learning activities such as discussion, reciprocal teaching, problem-solving, information organizing, and collaborative writing.

Statement of the Problem

The importance of Physics teaching and how teachers teach in their classrooms are being recognized as key importance in many ways. One main feature in the study of Physics is the development of concepts. However, conceptual understanding will be greatly hindered when the instruction in Physics focuses on drilling a standard problem in a fixed order, the sign is learned instead of the concept and a gap is produced between scientific practice and science as a subject of formal nature (Dayal et al., 2007, cited in Khan & Din, 2014).

Collaboration is currently an important notion in the implementation new education system in Myanmar. Currently, most teachers have been confused and concerned about the concept between cooperation and collaboration until they have been trained on how to teach the new curriculum during the 2020 summer vacation. According to Wiersema (2001), "Collaboration is more than co-operation. Co-operation is a technique to finish a certain product together: the faster, the better; the less work for each, the better. Collaboration refers to the whole process of learning, to students teaching each other, students teaching the teacher, and of course the teacher teaching the students too" (cited in Iborra, Garcia, Margalef, & Perez, 2010). Concept maps can support eliciting core ideas and connections and can make possible clusters or hierarchies visible. Implementation of concept maps can shift the epistemological authority from the teacher to the student, reduce the emphasis on right and wrong answers, and create visual entry points for learners of varying abilities. Taking into account the above signs of collaborative learning remarks and concepts maps remarks, this study was conducted by integrating the collaborative learning techniques and concept map creation steps in teaching Physics concepts.

Review of Related Literature

Philosophical Foundations: Collaborative learning techniques and creating concept mapping are child-centered teaching and active learning process. Progressivism, constructivism, and social constructivism are deeply taken into account in this study. The progressives believe that learning should be an active process and that students should do much more than receive information passively. Experience and experiment are two keywords for the progressives (Kneller,1971, cited in Hessong & Weeks, 1991).

According to constructivism, individuals create or construct their new understandings or knowledge through the interaction of what they already know and beliefs and the ideas, events, and activities with which they come in contact. Knowledge is acquired through involvement with content instead of imitation or repetition. Learning activities are created by active engagement, inquiry, problem solving, and collaboration with others (Siddiqui, 2008).

According to the social constructivists, learning is self-governed, problem-based, and collaborative. Learning is considered to be an interactive activity between what is known and what is to be learned. Individual development derives from social interactions. Individuals construct knowledge in transactions with the environment, and in the process, both the individual and the environment are changed. Meaningful learning occurs when individuals are engaged in social activities such as interaction and collaboration.

Learning Theories: Piaget's cognitive learning theory, Vygotsky's socio-cultural learning theory, Ausubel's meaningful learning theory, and information processing theory are also taken into account in developing the integrated collaborative concept mapping model. According to Piaget, the teachers will benefit when they understand at what levels their students are functioning. All students in a class should not be expected to operate at the same level (Wadsworth, 1996, cited in Schunk, 2012). Teachers can try to ascertain levels and gear their teaching accordingly. The students in grade ten fit with the formal operational stage. Students from Grade Ten can do mathematical calculations, think creatively, use abstract reasoning, and imagine the outcome of particular actions, and thus concept maps can be used as the proper tool for teaching concepts in Physics.

Vygotsky discusses the development of conceptual thinking, logical memory, and self-regulated attention. Helping students acquire cognitive mediators (e.g., signs, symbols) through the social environment involves the concept of instructional scaffolding. Reciprocal teaching comprises social interaction and scaffolding as students gradually develop skills. An important application area is peer collaboration, which reflects the notion of collective activity. Social interaction leads to more advanced cognitive development in the area of academic achievement. Providing opportunities for children to interact with others forces them to think and communicate about their thought.

From the point of view of Ausubel's theory, for meaningful learning to occur, three requirements must be met. First, the material to be learned must itself have potential meaning. Secondly, the learner must possess relevant concepts and propositions that can serve to anchor the new learning and assimilate new ideas. Thirdly, the learner must choose to relate the new information to his/her cognitive structure in a non-verbatim, substantive fashion. If any of these three elements are lacking, meaningful learning cannot occur, at least in the initial stages of a given learning sequence.

Background Teaching Models: The proposed new model was developed based on Dick and Carey's model for the systematic design of instruction, Glaser's Basic Teaching Model, Ned Flanders Model of Interaction Analysis, Neocybernetic Psychology-Based Model of Talyzina, and Khin Zaw's Model of Multimodal. Moreover, for teaching problem solving, Dewey's Problem-Solving Model is used in developing the proposed model.

The proposed model, an integrated collaborative concept mapping model, is intended to contribute to Physics teaching by dealing with teaching concepts and solving problems to be a more active learning process and more meaningful. This model consists of three main components. They are planning, instructional maneuver phases, and evaluation. In planning, selecting learning contents, identifying instructional goals and learning objectives, preparing relevant test items, assigning instructional techniques, and preparing instructional materials are included. In instructional maneuver phases, the preliminary phase such as recalling prior knowledge, linking new knowledge (Pre), grouping; expounding phase such as expounding the theory/concept, linking new knowledge (During), identifying the focus problem; exploration phase such as guiding for constructing concept maps, approaching drawing maps, group problem solving is involved. And the last phase, the closure phase is composed of summarizing the concepts/ solutions. The final step of the model is the evaluation in which formative assessment (pre-instruction), summative assessment (post instruction), and feedback processes are included (See Figure 1).

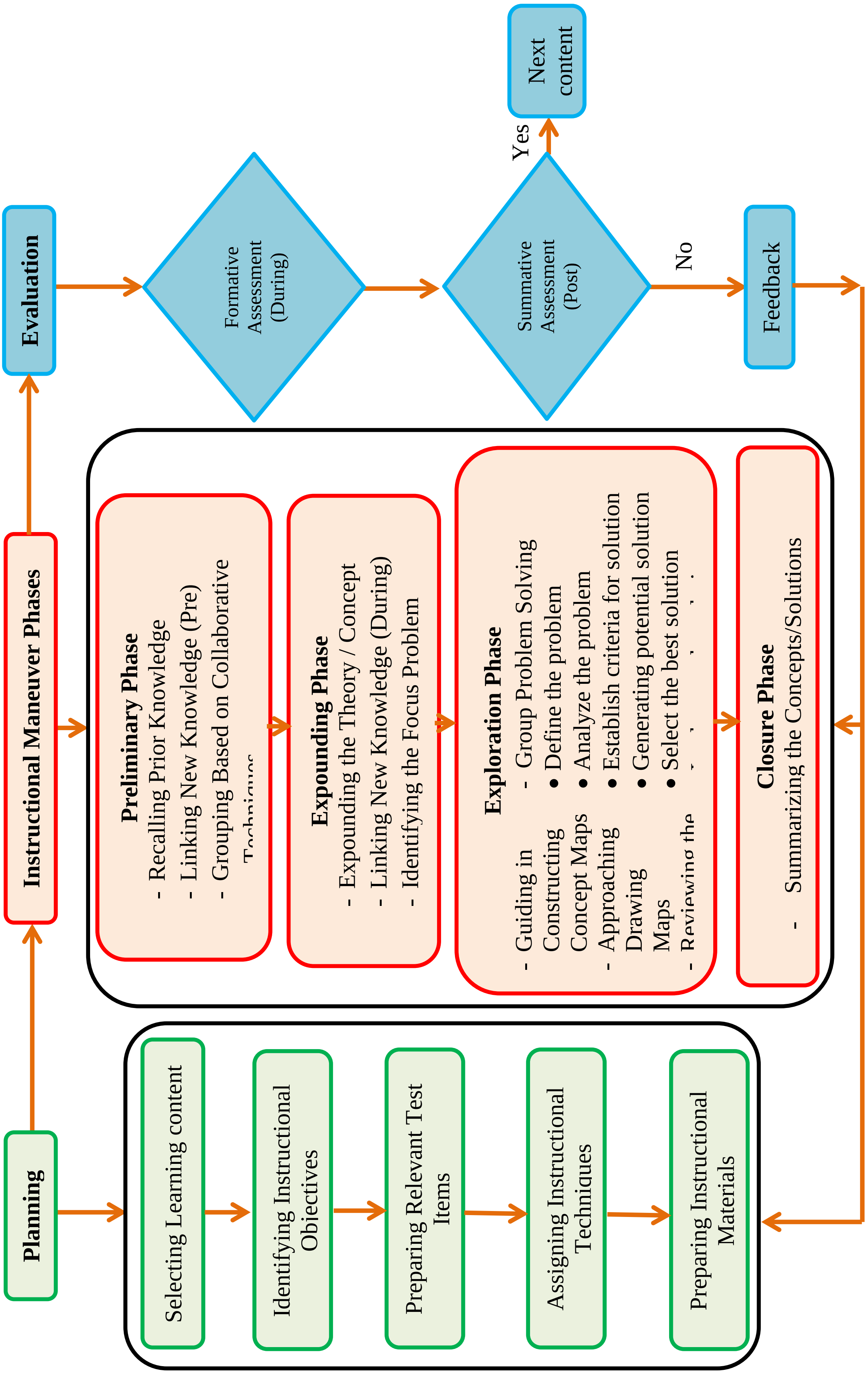
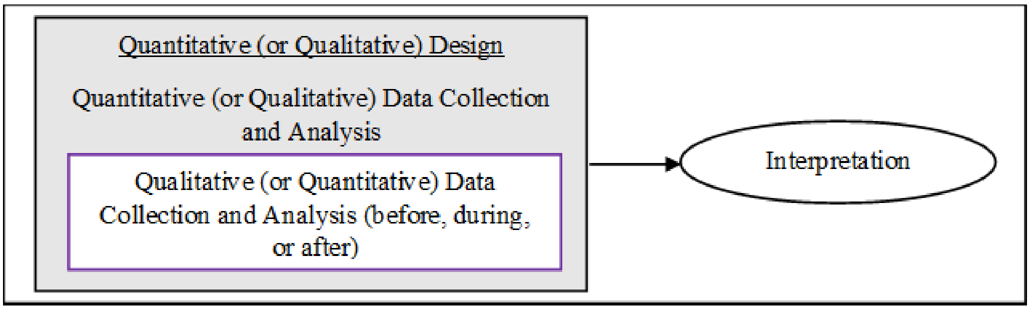


Figure 1 An Integrated Collaborative Concept Mapping Model

Methods

Research Design: In this study, one of the mixed-method research designs, the embedded design was used in which the qualitative method was embedded in quantitative research. Quantitative data was primary and qualitative data was secondary data to support the findings of quantitative results (See Figure 2).



Source: From Creswell and Plano Clark (2011), p. 111.

Figure 2 The Embedded Design

Quantitative Research Design: As the experimental research design, one of the quasi-experimental designs: a nonequivalent control group design was chosen. Population and sample size are described in Table 1.

Table 1 Population and Sample Size for Quantitative Research

Region	District	Township	School	No. of Population	No. of Sample		Group
Yangon	East	North Okkalapa	No. (3) BEHS	125	50	25	Experimental Group
						25	Control Group
	West	Bahan	No. (2) BEHS	183	42	21	Experimental Group
						21	Control Group
	South	Thanlyin	No. (2) BEHS	102	44	22	Experimental Group
						22	Control Group
	North	Mingaladon	No. (1) BEHS	230	64	32	Experimental Group
						32	Control Group
	Total			640	200	100	Experimental Group
						100	Control Group

Note. BEHS = Basic Education High School

Instruments

Pretest, posttest, self-assessment form, and questionnaires were used as quantitative research instruments, and semi-structured interview questions and observation checklists were used as qualitative research instruments.

Procedure

The model was developed and required instruments and lesson plans were prepared first. After taking validation, a pilot study was conducted. Qualitative data were collected before intervention by interviewing and administering questionnaires to both the students and teachers. After that, the intervention was followed. During the intervention, observation checklists and self-assessment forms were used. Finally, a posttest was administered to both groups. Then interviewing process was conducted again.

Data Analysis

Statistical Package for the Social Science (SPSS) was mainly used to generate descriptive statistics to compare the achievement results of students from both groups. One-way Analysis of Covariance (ANCOVA) was used to analyze the quantitative data, Wilcoxon Signed Ranks Test was used to know the differences between before and after intervention dealing with the attitude changes concerning the implemented model. And Friedman Test was also used to show the improvements of soft skills which are compared among three times points and thematic analysis was used for qualitative data.

Findings

In this research, two parts of research findings were presented systematically. The first one is quantitative findings and the second one is qualitative findings.

Quantitative Research Findings: One-way analysis of covariance (ANCOVA) to reveal the results for hypothesis H1: there is a significant difference in achievement scores between Grade Ten students who are instructed by using the model based on collaborative learning techniques and concept mapping and who are not received it. The following table 2 described the initial results in four schools.

Table 2 Analysis of Covariance (ANCOVA) Results of Pretest Scores on Initial Ability in Four Schools

School	Group	N	M	SD	MD	*F*	*p*	Partial Eta Squared
S1	Experimental	25	33.08	3.43	- 4.00	9.603	$.003^{**}$	.16
	Control	25	37.08	5.46				
S2	Experimental	21	26.57	7.16	2.24	1.245	.271(ns)	.03
	Control	21	24.33	5.76				
S3	Experimental	22	27.68	8.09	-12.37	36.258	$.000^{***}$	.46
	Control	22	40.05	5.21				
S4	Experimental	32	32.88	2.11	3.10	8.915	$.004^{**}$	.12
	Control	32	29.78	5.47				

Note. S1 = No. (3) Basic Education High School, North Okkalapa, S 2 = No. (2) Basic Education High School, Bahan, S 3 = No. (2) Basic Education High School, Thanlyin,

S 4 = No. (1) Basic Education High School, Mingaladon, ns = not significant, $^{***}p < .001$. $^{**}p < .01$.

There were significant differences between the initial knowledge of experimental groups and control groups in school 1, school 3, and school 4. According to the result of school 2, there was no significant difference between the two groups.

The post-test results on Physics achievement in four schools are presented in Table 3.

Table 3 Analysis of Covariance (ANCOVA) Results of Posttest Scores on Physics Achievement in Four Schools

School	Group	N	Unadjusted M	Adjusted M	MD	*F*	*p*	Partial Eta Squared
S1	Experimental	25	24.00	24.61	4.78	21.23	$.000^{***}$	.150
	Control	25	20.44	19.83				
S2	Experimental	21	29.48	29.05	11.24	15.40	$.000^{***}$	.070
	Control	21	17.38	17.81				
S3	Experimental	22	24.95	26.67	14.06	25.91	$.000^{***}$	.075
	Control	22	14.32	12.61				
S4	Experimental	32	27.00	26.68	14.92	223.02	$.000^{***}$	.053
	Control	32	11.44	11.76				

Note. $^{***}p < .001$.

In four schools, after adjusting for pre-intervention scores (pretest scores) as covariate, there were significant differences between the two groups on post-intervention scores (posttest scores) on Physics achievement according to the adjusted mean scores for school 1 (24.61,19.83) and F (1,47) = 21.23, p =.000, for school 2 (29.05,17.81) and F (1,39) = 15.40, p =.000, for school 3 (26.67,12.61) and F (1,41) = 25.91, p =.000, and for school 4 (26.68,11.76) and F (1,61) = 223.02, p =.000. There were no significant relationships between the pretest scores and posttest scores, as indicated by a partial eta squared values of .15 for school 1, .07 for school 2, .075 for school 3, and .053 for school 4. According to Cohen's (1988) guidelines (cited in Cohen, Manion & Morrison, 2018), the value .15 is a large effect size, the value .07 is a medium effect size, and .05 is a small effect size.

From the above data, it can be interpreted that the two groups from each school were not the same on the dependent variable because their mean scores showed the fact that the experimental groups have better achievement on the Physics achievement test than the control groups. Therefore, it can be assumed that the students of experimental groups gained a significant effect due to the utilization of an integrated collaborative concept mapping model in teaching Physics. In other words, it can be interpreted that the experimental treatment or the implemented model has a significant positive effect on Grade Ten Students' Physics learning.

Findings of Wilcoxon Signed Rank Test for Students' Attitudes Questionnaires

In using Wilcoxon Signed Rank Test, the z value and the associated significance levels presented as Asymp. Sig. (2-tailed) need to be checked. If the significance level is equal to or less than .05, the difference between the two scores is statistically significant (Pallant, 2010) (See Table 4).

Table 4 Wilcoxon Signed Rank Test Results for Students' Attitudes

School	No. of Participant	Component	Before Md	After Md	z	Asymp. Sig(2-tailed) *p*	*r*
S1	25	AP	46	59	-3.217	.001**	.45
		ACLT	54	62	-2.755	.006**	.38
		ACM	50	60	-3.609	.000***	.51
S2	21	AP	51	58	-3.340	.001**	.51
		ACLT	56	60	-2.368	.018*	.36
		ACM	49	60	-3.981	.000***	.61
S3	22	AP	55	59	-2.243	.025*	.33
		ACLT	58	64	-2.634	.008**	.39
		ACM	53	60	-3.738	.000***	.56
S4	32	AP	51	55	-3.071	.002**	.38
		ACLT	59	63	-1.822	.068(ns)	.22
		ACM	48	58	-4.509	.000***	.56
All four schools	100	AP	52	58	-6.001	.000***	.42
		ACLT	58	62	-4.758	.000***	.33
		ACM	50	60	-7.914	.000***	.55

Note. AP = attitudes towards Physics, ACLT= attitudes towards collaborative learning techniques, ACM= attitudes towards creating concept maps, Md = Median, ns= not significant, $^{***}p < .001$. $^{**}p < .01$. $^{*}p < .05$.

In all four schools as the overall results, Wilcoxon Signed Rank Test revealed a significant difference dealing with attitudes towards Physics, collaborative learning techniques, and creating concept maps between before intervention (Time 1) and after intervention (Time 2), z = -6.001, 4.758, - 7.914, p = .000, .000, .000 (p = <.000), with medium and large effect size (r= .42, .33, .55). The median score on the attitudes towards Physics increased from before intervention (Md = 52) to after intervention (Md = 58). The median score on the attitudes towards collaborative learning techniques increased from before intervention (Md = 58) to after intervention (Md = 62). The median score on the attitudes towards creating concept maps increased from before intervention (Md = 50) to after intervention (Md = 60). It can be interpreted that the positive attitudes dealing with the three components increase after the intervention and there was a significant difference in the attitudes of students towards learning Physics who were instructed by using the model based on collaborative learning techniques and concept mapping before and after intervention in all four schools.

Friedman Test Results for Self-Assessment Form Linking to 5 Cs

The assessment form contains five components for 5 Cs and is administered to the participants at least three times (the first week of the intervention, in the middle of the intervention, and at the end of the intervention). According to Pallant (2010), in analyzing these data, one sample of participants, measured on the same scale or measured at three different time periods is required. Therefore, the collected data were analyzed by using Friedman Test. In analyzing these data, Asymp. Sig. level, median, and mean rank are required to compare the results. Comparing mean rank is the main fact in deciding whether there is an improvement or not dealing with the testing area causes of the treatment. If the mean ranks are increasing, it can be interpreted that there is an improvement (See Table 5).

Table 5 Friedman Test Results of Self-Assessments on 5 Cs in Overall Schools

School	No. of Student	5 Cs	Mean Rank			Md (Median)			*df*	*Chi-Square* X^2	*p*
			B	D	A	B	D	A			
All four schools	100	C1	1.67	1.88	2.46	18	19	20	2	37.358	$.000^{***}$
		C2	1.59	1.86	2.56	17	18	20	2	57.926	$.000^{***}$
		C3	1.73	1.83	2.45	16	17	19	2	34.381	$.000^{***}$
		C4	1.50	1.96	2.55	16	18	20	2	62.695	$.000^{***}$
		C5	1.72	1.96	2.32	19	19	20	2	20.494	$.000^{***}$

Note. C1 = Collaboration, C2 = Communication, C3 = Critical Thinking and Problem Solving, C4 = Creativity and Innovation, C5 = Citizenship, B = Before, D = During, A = After, $^{***}p < .001$.

The expressed data can be interpreted that there is a change in skills dealing with 5 Cs across three time periods. Comparing the Mean Ranks for the three sets of scores, it appears that there were improvements in all 5 Cs over time in all participants. It can be interpreted that applying an integrated collaborative concept mapping model in teaching physics let the students improve their soft skills along with learning deep Physics concepts.

Qualitative Research Findings: Based on the research design, qualitative data was collected first because the qualitative phase of the study is intended to provide data to support or supplement the quantitative data from the experimental design. In this design, semi-structured interviews and observation (during) were conducted before intervention and after the intervention. The validity of the qualitative results can be enhanced by the quantitative results. Thematic analysis for both interview and observation data are described as the following.

Findings of Students' Interview: Thematic analysis results for students/teachers' interview responses are expressed in tabulated forms.

Table 6 Display Data for Students' Interview Responses

No.	Main Theme	Sub Theme	Response	Before (%)	After (%)
1	Attitudes on Physics Learning	Reasons of learning	- Interested in Physics/calculation - As a subject/including in curriculum - Support for further learning	44 34 9	53 9 19
		Like/ Dislike	- Like - Dislike	78 22	91 9
		Usefulness for self	- Useless - No answer (Silence) - Usefulness	6 16 78	3 0 97
		Teaching methods	- Formal teaching - Proposed model	100 0	0 100
		Effectiveness for daily life	- Not accept the assumption - Accept assumptions	25 75	16 94
		Extra learning	- No - Yes (Google / YouTube)	66 34	13 87
2	Attitudes towards Collaborative Learning Techniques	Learning style	- Individual learning - Group learning	6 94	3 97
		Understanding	- No answer (Silence) - Unknown exactly - 4 or 5 per group work together - Cooperation - Sharing knowledge - Collaboration (work by group)	16 31 31 3 13 6	0 3 6 0 3 88
		Enjoying	- Dislike - Like	16 84	0 100
		Assigning Groups	- Group by teacher - Group by wish	81 19	100 78
		Kinds of a well-organized group	- Academic (good, fair, poor) - Unity/ active / negotiation/ social - 4/5/6 per group (members) - Good intelligence - No answer (Silence) - Responsibility	25 31 31 6 6 0	31 34 0 0 0 34
		Assigning Tasks	- Assign tasks for individual - Solve by the strength of unity	91 9	0 100
		Motivation	- Help each other	100	100
		Assessment	- Assess by teacher - Assess by peer - Not assess	100 81 19	0 100 0
		Benefits	- Friendships, Social interaction skills, Communication skills	100	100
3	Attitudes on Creating Concept Maps	Experience	- Learnt before (accept) - Learnt before (not accept)	0 100	100 0
		Interest	- Uninteresting - Interesting	6 94	0 100
		Usefulness	- No answer (Silence) - Identify misconceptions	63 38	0 100
		Benefits / Drawbacks	- No answer (Silence) - Benefits	41 59	0 100

Table 7 Display Data for Teachers' Interview Responses

No.	Main Theme	Sub Theme	Response	Before (%)	After (%)
1	Understanding Collaborative Learning Techniques	Collaboration	- Exchange ideas/knowledge	50	100
		An effective learning group	- Academic (good, fair, poor) - Competition groups - Heterogeneous groups	25 25 25	100 0 0
		Causes	- Competitions - Cooperation - Sharing knowledge - Negotiation	25 25 25 25	100 0 0 0
		Consideration facts	- Individual ability, Fair groups - Heterogeneous, Intelligence	75 0	100 0
		Difficulties	- Time-consuming	100	100
		Ways of grouping	- School Council Teams - Rows - Heterogeneous groups - Randomly	25 50 25 0	0 0 0 100
2	Assessment	Participation	- Active participation - Check around the group	50 50	100 0
		Exchanged strategies	- Explaining again but coach - Asking easy questions	100 0	100 0
		Improvements	- Assess by looks	100	100
3	Expected Outcomes	Skills	- Observation / Social skills	100	100
		Feelings	- Good if time enough	100	100

Table 8 Results of Classroom Observation Checklists for Teachers

Phase	Observed Factor	Frequency	%
Preliminary Phase	1. Begins class on time.	74	77.0
	2. Review prior class concepts.		81.9
	3. Appears well-prepared for class.		79.2
	4. Related today's lesson to previous.		83.8
	5. Provided clear directions for grouping.		83.8
Average %			**81.1**
Expounding Phase	1. Used good examples to clarify points.	74	77.0
	2. Provided group tasks.		78.4
	3. Related new ideas to familiar concepts.		79.7
	4. Explained major/ minor points with clarity.		84.3
	5. Defined unfamiliar terms, concepts, and principles.		81.9
	6. Emphasized important points.		85.7
	7. Responded appropriately to non-engaged students.		81.9
	8. Effectively managed time.		81.6
	9. Identify the focus concept or problems.		84.1
	10. Explicitly states relationships.		85.9
Average %			**82.1**
Exploration Phase	1. Monitor every group's activity all the time.	74	81.4
	2. Actively encouraged student questions.		83.8
	3. Treats class members equitably.		83.2
	4. Encourages mutual respect among students.		83.8
	5. Provides enough time for reviewing the maps.		81.9
	6. Allows sufficient time for completion.		84.6
	7. Provides enough time for problem-solving.		85.7
Average %			**83.5**
Closure Phase	1. Summarize the concepts together with all the students.	74	81.9
	2. Evaluate the concepts maps or solutions.		82.2
	3. Deliver the evaluation test questions.		84.9
Average %			**83.0**

Table 9 Results of Classroom Observation Checklists for Students

Main Theme	Observed Factor	Frequency	%
Collaboration	Focused on team activities.	74	80.81
	Stay in the group until the activities finish.		85.41
	Demonstrate good self-control.		81.89
	Ask useful questions to deepen the study.		81.89
	Share information that they collected.		81.62
	Share personal views.		81.08
	Well prepared for group activities.		85.95
	Explain ideas with clarity and appropriate concepts.		76.76
	Give helpful feedback.		75.14
	Accept useful feedback.		75.14
Average %			**80.59**
During Learning	Listen attentively.	74	92.97
	Answer actively.		81.62
	Asks misunderstanding facts at once.		84.05
	Accept assigning group works.		96.76
	Pay attention to other's sharing ideas.		81.89
	Average %		**87.46**
Creating Concept Maps	Well prepare to create a concept map.	74	78.92
	Record the facts systematically.		78.92
	Accept others' useful and helpful opinion.		79.19
	Conduct interestingly.		82.43
	Explain the created concept map clearly.		84.86
Average %			**80.86**

Summaries of the research findings are as follows:

1. According to the quantitative results, the experimental groups scored significantly higher than the control groups on achievement scores.
2. According to the qualitative results, there were significant differences in the attitudes of students towards learning Physics who were in experimental groups before and after the intervention. Their attitudes changed positively.
3. According to the responses of teachers, there were slightly changes in the attitudes towards using the proposed model before and after the intervention.
4. According to the Fried man test results, there were significant changes in the students' acquired soft skills after intervention in all schools.
5. According to the results of thematic analysis for observation and interview, the students who participated as experimental group members actively participated in the intervention periods

Discussion

On the overall Physics achievement, there were significant differences in initial knowledge of Physics for the pretest between the control and experimental groups. Based on the overall results, showed that the control groups had more initial background knowledge of Physics than the experimental groups. But the results of the one-way analysis of covariance (ANCOVA) for posttest scores conversed with the initial results. The ANCOVA results showed that the students from the experimental groups performed better than those who participated in the control groups in overall achievement in Physics. Therefore, it can be interpreted that the use of the proposed model, An

Integrated Collaborative Concept Mapping Model, significantly improves the students' achievement in Physics causes of increasing their conceptual understanding. This result is in line with the study of Doris (2018) that the students who taught with the concept mapping mode of instruction performed significantly better than those taught with conventional modes. This study recommended that teachers should imbibe the concept mapping method in the teaching of Physics to enhance students' comprehension and identification of relationships that exist between concepts and creativity.

Significant improvement was found in the students' attitudes towards Physics when interviewing 32 students who were selected purposively from the experimental groups. The percentage results indicated that the Integrated Collaborative Concept Mapping Model performed better in positive attitude changes. This study is in line with the result obtained from the study of the effect of concept mapping on attitude and achievement in a Physics course conducted by Karakuyu (2010) that expressed that the experimental group students were observed to have a tendency of more positive attitude than the control group students.

Wilcoxon Signed Rank Test for students' attitudes questionnaires revealed significant differences dealing with attitudes towards Physics, collaborative learning, and creating concept maps between before intervention (Time 1) and after intervention (Time 2) in school 1, school 2, school 3, and school 4. But no significant difference was found in attitudes towards collaborative learning in school 4.

Friedman Test results showed that the improvement was found in all the collaboration skills, communication skills, critical thinking and problem-solving skills, creativity and innovation skills, and citizenship. There were statistically significant differences in self-assessment scores across the three-time points. It can be interpreted that Integrated Collaborative Concept Mapping Model enhances students' soft skills.

Moreover, using the integrated collaborative concept mapping model in teaching Physics can enhance students' positive attitudes towards Physics learning. Thus, it can be said that the second research hypothesis was accepted by these findings.

The interviewee teachers agreed that the Integrated Collaborative Concept Mapping utilizing is more valuable for them if they have time enough. In the current situation, they have insufficient time to implement this model completely in their teaching. Nevertheless, from the finding of the teachers' interviews, it can be interpreted that this integrated collaborative concept mapping model is effective in teaching Physics. The results of observation showed the implementation percentage of the Integrated Collaborative Concept Mapping Model. The results showed that 80% were successful in implementing this model. Causes of their hardworking manner to implement this teaching process, the expected results were obtained. Therefore, it can be interpreted that teachers' attitudes towards the proposed model changed over time properly when comparing before and after the intervention.

Suggestions

Suggestions for Physics Teachers: Teachers should exactly know what collaboration is, how to use it, and the usefulness of concept map creation in their teaching. They should know the grouping nature in using collaboration. Teachers could review each group's performance to monitor participation and progress and intervene when the need arises. Moreover, the teacher should explain the purpose and usefulness of a task before students carry out the task. This arouses the learners' interest.

Suggestions for Physics Students: All the students should be suggested that collaborative concept mapping is not a boring technique, and is capable of systematically study with it by giving proper time, a deep understanding of Physics concepts and the expected achievement in Physics can be acquired.

Suggestions for School Administrators: In other countries, concept map creation is studied with computers. In this research, although the students performed the creation of concept maps with paper and pencil, they all proved that it is very beneficial for them. Therefore, if it is possible, the required computers should be supported for each school.

Recommendations

1. According to the obtained results of this current research, it is claimed that teaching Physics concepts with the Integrated Collaborative Concept Mapping Model can enhance the students' achievement in Physics along with a deep understanding of the concepts. Moreover, applying this model with formal procedures can prepare the students to explore and develop their own abilities to work collaboratively, communicate effectively and convince others with their own ideas and critical thinking and problem-solving skills. Furthermore, it can improve the students' positive attitudes concerning learning Physics because it lets them acquire a deep understanding of the concept taught in the classroom.
2. For further implementation of concept mapping in the future and to enhance the enthusiasm of teachers in giving Physics courses; intensive training for the teachers is highly recommended to implement concept mapping not only in Physics but also in other disciples.
3. In this study sample schools were randomly selected from Yangon Region. Further research should be carried out for the rest states and regions for replication.
4. This study was conducted for only three chapters from Physics Textbook (2020-2021). Further research should be carried out for the whole syllabus.
5. Some of the collaborative learning techniques were used in the present study. Further studies should be carried out by other collaborative learning techniques.

Conclusion

The Ministry of Education (MOE) is committed to improving the basic education curriculum to make it more relevant to the lives of students by focusing on 21st -century skills, soft skills (including personal development and employability skills), and higher-order thinking skills. According to the obtained results from this study, the use of the integrated collaborative concept mapping model is more supportive than formal instruction which was emphasizing the teacher-centered approach to teaching Physics concepts at the secondary high school level. Friedman Test results showed that the improvement was found in all the collaboration skills, communication skills, critical thinking and problem-solving skills, creativity and innovation skills, and citizenship. Thus, the integrated collaborative concept mapping model can enhance students' soft skills.

To sum up, the Physics teacher should avoid emphasizing the teacher-centered (giving explanation, questioning and answering, as well as doing homework) which do not provide opportunities for students to develop creativity and critical thinking. Emphasizing the learner-centered (letting students use the power of reason to enable a way of what to think and how their thinking processes are, through the learning methods of collaborative concept mapping, discovery, discussion, experimentation, and other methods) should be favored in the current 21st-century classroom. Collaborative concept mapping is an active learning strategy that moves the students beyond rote memorization to critical thinking and is meaningful learning in the classroom both for teachers and students.

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