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Modified Questioning Strategy in small class size and its comparative effect on Academic Achievement of students in Physics and Human Kinetic and Health Education: A pilot study

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Abstract: *Teacher's questioning and its effectiveness is an important aspect of teaching-learning process with significant influence on students' academic performances. This study examined the effect of Modified Questioning Strategy (MQS) in small class size on academic achievements of students in Physics and Human Kinetics and Health Education (KHE), compared to Lecture Method (LM). The study employed quasi-experimental research design, using a sample of 80 students selected from Physics and Human Kinetics and Health Education (KHE) departments. The selected students were divided into 4 groups: Physics experimental and control groups as well as KHE experimental and control groups. Data were collected through a self structured Physics Achievement Test, KHE achievement Test and Modified Questioning Strategy Scale. The collected data were analyzed using mean, standard deviation and t-test statistics at 0.05 level of significance. The findings of this study revealed that; (i)MQS improved academic achievement of students in Physics and KHE better than LM (MQS: MS, Physics = 20.15 > LM: MS, Physics = 15.10; and MQS: MS, KHE = 21.34 > LM: MS, KHE = 14.60); (ii) MQS improves students' academic achievement in KHE better than in Physics (GS: KHE = 22.33 % > GS: Physics = 16.67 %); (iii) there was a significant difference in academic achievements of Physics and KHE students taught using MQS and those taught using LM (Physics: t-cal = 27.95 > t-table = 1.68 and KHE: t-cal = 27.24 > t-table = 1.68 at p<0.05) (iv) there was a significant difference in the academic achievements of Physics and KHE students taught using MQS (t-cal=5.95 > t-table = 1.68 at p<0.05). It was therefore recommended that government and school authorities should organize workshops and seminars for science teachers on application of MQS and encourage them to use it in their teaching activities.*

Key words*: Questioning, Academic achievement, Physics, Human Kinetic and Health Education*

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I. Introduction

Physics is a natural science generally regarded as an abstract and difficult, with concepts and techniques that supports the development of other areas of science such as engineering, medicine, agriculture, pharmacy and other science based courses, consequently leading scientific and technological development. Ogunleye (2001) asserted that the technological potentials of any nation could be more accurately gauged by the quality of its physics education, for without Physics; the technological culture of her citizens cannot be firmly rooted.

Human Kinetics and Health Education (KHE) is a discipline focused on the comprehensive study and practice of human movement and exercise, its impact on health and physical performance as well as educating people about health. Matazu (2017) defines Human Kinetics as a science of human movement, with relevance in fitness instruction, physiotherapy and neuroscience, amongst others, while WHO (2020) defines Health education as any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes.

Questioning method is the process in which sequence of suitable questions are asked with the objective of leading the students to draw a logical conclusion or generalization (Special Teacher Upgrading Programme, 2007 cited in Adeyemi, 2018). Questioning is a core function of both learning and teaching (Wells, 2001). Questions as an educational tool are stimulants which activate students' cognitive skills (Aydemir & Çiftçi, 2008). Teaching and learning by questioning strategy requires the teacher to be able express all necessary questions relating to the concepts and knowledge intended for the students in a more clearer and efficient manner so that the students can have very solid understanding of the lesson concept. Teaching-learning by questioning can greatly improve teacher-students interactions, student-student interactions, students' motivation

to learn, students' reasoning and thinking ability as well as their Intelligence Quotient, IQ. Well structured, quality and effective questions enhances students' concentration during teaching-learning process, familiarize students to examination-like condition and allows teachers evaluate the rate of students' assimilation of the learning concepts.

According to Yang (2006) teacher's questions can be considered as the most powerful device to lead, extend and control communication in the classroom. Adeyemi (2018) asserted that questions that focus students' attention on important elements of a lesson result in better comprehension, than those that focus on unusual or interesting elements, and as such questions should be structured in order to elicit most correct responses, such as a change in attitude. Questioning during teaching-learning process help students develop their own problem solving skills (Hu, 2015) and store knowledge (Dos & Demir, 2013). Questions have been tagged as new answers and its critical use in the field of education is crucial (Berger, 2014). Research studies have showed that there is a strong relationship between teachers' questioning behaviour and students' achievement in English Language (Fakeye & Ayede, 2013). Adeyemi (2018) in his study observed a significant effect of questioning instructional strategies on students' performance and students' retention in Social Studies. Tanner (2012) observed that questioning improves academic achievement and as well develops their meta-cognitive thinking. In other studies, teachers questioning behavior had been reported to have significant influence in developing and guiding students' thought processes, quality of students' responses and students' learning (Fakeye, 2007; Akandi, 2009 cited in Fakeye & Ayede, 2013). Similarly, teachers' questions or questioning behavior was observed to determine the extent to which students learn and think in the classroom (Kira, Komba, Kafanabo & Tilya, 2013).

Modified Questioning Strategy (MQS) is an instructional method which uses student grouping, textbooks/study materials and well defined questions specifically based on the lesson topic to achieve the goals and objectives of the lesson. MQS as designed and used in this study involves the teacher and students in a strict, evolving and all action activities and interactions. The concepts of MQS applied in this study are as follows:

(a) **Teacher's Pre-class activity:** Before the class, the teacher construct study questions on the lesson topic he/she intends to teach, using the topic's learning objectives as a guide.

(b) **Revision and Introduction:** The teacher briefly revises the previous topic with the students and introduces the new topic.

(c) **Class setting:** The teacher divides the class randomly into study groups, consisting of 2 - 10 students each. Each group is allowed by the teacher to choose their group leader without interference.

(d) **MQS Instruction:** The teacher writes the study questions on the board and instructs the students to answer them within their study groups using their textbooks/study manuals and collective brain-storming, for some given duration of time.

(e) **Student groups' activity:** The students within their respective study groups answer the study questions using their textbooks/study manuals, collective group discussion and brain-storming,

(f) **Supervision:** The teacher closely supervises the class and the groups to ensure all the students participate actively within their groups during the learning process.

(g) **Evaluation and discussion:** At the expiration of the given duration of time, the teacher stops the students and demands for their answers to the study questions in question by question and group by group format. The teacher with collective efforts of the students acknowledges the correct answers and encourages the students irrespective of whether their answers are correct or not. The teacher then gives his/her preferred or best answers to the questions and explains them.

(h) **Conclusion:** The teacher asks further questions on the lesson topic to ascertain full understanding and assimilation of topic concepts, especially in areas where corrections were made. He allows the students to answer and makes necessary corrections.

Statement of problem

Physics and KHE are among science courses with low enrolment and small class size in higher institutions when compared with other courses like accounting, business administration, mass communication, etc. Despite the low enrolment and its consequence small class size, many students still perform poorly in the courses, thus ending up with poor or average grades which have been persistent over the years. This situation has continuously poised a threat to the country's production of Physics, Physical and health educators at the highest level, and an even greater threat to the country's technological and socio-economic development as well as the mental and physical health of the future generation of scientists. Mokuolu, Fatoba & Ogundipe (2013) asserted that poor and ineffective teaching and learning which arose from combined influence of teachers, system and students' factors are responsible for the reoccurring problems of poor performance in Physics. Based on this, there is a need for a method of instruction that can improve students' academic achievement in Physics and KHE, so that the dwindling science, technological and socio-economic future of our society can be

remedied. One of such instructional method which is yet to be studied on Physics and KHE is Modified Questioning Strategy (MQS).

Purpose of the study

The main purpose of this study is to determine the effects of Modified Questioning Strategy (MQS) in small class size on academic achievement of students in Physics and Kinetic and Health Education (KHE) compared to the Lecture Method (LM). It also intends to investigate the perceived opinion of the students regarding the use of MQS in teaching and learning of Physics and KHE.

Research Questions

1. What are the perceptions of the students regarding the use of Modified Questioning Strategy (MQS) in teaching and learning of Physics and KHE?
2. What is the effect of Modified Questioning Strategy (MQS) on academic achievement of students in Physics and KHE?
3. Does MQS influence students' academic achievement in Physics better than in KHE?

Research Hypotheses

The following null hypotheses were tested:

Ho_1: There is no significant difference in the mean academic achievement scores of Physics students taught by MQS and those taught by Lecture Method (LM).

Ho_2: There is no significant difference in the mean academic achievement scores of KHE students taught by MQS and those taught by Lecture Method (LM).

Ho_3: There is no significant difference in the mean academic achievement scores of Physics and KHE students taught by MQS.

Ho_4: There is no significant difference in the mean perception ratings of Physics and KHE students concerning the use of MQS in teaching and learning of Physics and KHE.

II. Methodology

Design, Population and Sample

This study was based on quasi-experimental research design with two groups: experimental and control. The population for the study comprises of all Physics (Nigeria Certificate of Education, NCE) students in School of Science, Federal College of Education, Abeokuta; as well as Human Kinetic and Health Education, KHE (Degree) students of University of Ibadan (in affiliation with Centre for Degree Programmes, Federal College of Education), Abeokuta, Ogun state.

A study sample of 80 Physics and KHE (Year two) students were randomly selected. The selected students were divided into experimental and control groups: Physics Experimental (13 males and 7 females), Physics Control (11 males and 9 females), KHE Experimental (15 males and 5 females) and KHE Control (16 males and 4 females) groups, such that each group is made up of 20 students.

Instrument

The instruments used for this study are Physics Achievement Test (PAT), Human Kinetic and Health Education Achievement Test (KHEAT), Modified Questioning Strategy Guide (MQSG) and Modified Questioning Strategy Scale (MQSS). The PAT and KHEAT are developed by the researchers to evaluate students' academic achievement. The PAT contains 30 multiple choice objective questions with options A to D, drawn from three topics: Direct current, Electromagnetic Induction, R-L and R-C circuits. The KHEAT also contains 30 multiple choice objective questions with options A to D, drawn also from three topics: Personality and sport performance, Management and techniques for prevention of stress, Hooliganism and sport. The MQSG is an instructional guide containing procedures and methods of teaching the research topics in Physics and KHE.

The Modified Questioning Strategy Scale (MQSS) is a questionnaire made up of sections A and B. Section A contains bio-data information of the respondents, while section B consists of twelve (12) items designed to obtain information on perception of students regarding the use of MQS in teaching and learning of Physics and KHE. The MQSS items were responded to, based on the four likert-scale rating: Strongly Agree (SA = 4 points), Agree (A = 3 points), Disagree (D = 2 points), and Strongly Disagree (SD = 1 point). The questionnaire was validated by experts in test and measurement, and a reliability coefficient of 0.81 was obtained using Pearson product moment correlation.

Treatment

The Physics and KHE control groups were taught using the lecture method while the Physics and KHE experimental groups taught using MQS with the aid of MQSG. The same topics were taught in Physics experimental and control groups. Likewise, in KHE experimental and control groups, the same topics were taught. The whole treatment duration for both control and experimental (Physics and KHE) groups was 3 weeks each. All necessary actions and precautions were taken by the researchers to prevent unnecessary suspicion from the students regarding what their groups and teaching methods is all about, as well as what the researchers intend to achieve.

Data Collection and Analysis

After the treatment period, the Physics experimental and control groups were subjected to Physics Achievement Test (PAT), while the KHE experimental and control groups subjected to KHE achievement Test (KHEAT) under strict examination conditions for 45 minutes each. Each question carries 1 mark for maximum obtainable score of 30 marks. After the administration of the achievement tests, the Physics and KHE experimental groups were given the MQSS to answer and were monitored under strict examination conditions to avoid sharing of ideas.

The collected data were analyzed using mean, standard deviation and t-test statistic at 0.05 level of significance. In analyzing the Modified Questioning Strategy Scale (MQSS), the Mean Response Rating (MRR) of the students to each item of the MQSS was used to determine the perceived decision for such item. The Perceived Decision (PD) which is either Generally Agreed (GA) or Generally Disagreed (GD) was based on Mean Response Ratings (MRR) 1 – 2.49 and 2.50 – 4.00, respectively.

III. Results and Discussion

Research Question 1: What are the perceptions of the students (Physics and KHE) regarding the use of Modified Questioning Strategy (MQS) in teaching and learning of Physics and KHE?

Table 1: Mean perception responses of students to MQSS in teaching and learning

			Physics Students			KHE Students		
SN	**MQS in teaching and learning**	**N**	**MRR**	**SD**	**PD**	**MRR**	**SD**	**PD**
1.	I like MQS of teaching.	20	2.90	0.91	GA	2.60	0.99	GA
2.	MQS makes learning too rigorous.	20	2.35	0.67	GA	3.15	0.76	GA
3.	It can improve teacher-students and student-student interactions.	20	3.25	0.44	GA	3.20	0.54	GA
4.	It can improve students' intellectual thinking and reasoning	20	2.75	0.77	GA	2.60	0.75	GA
5.	It forces students to be actively involved in learning activity.	20	3.35	0.49	GA	3.05	0.55	GA
6.	It enhances students' concentration and understanding during learning.	20	3.10	0.64	GA	2.95	0.61	GA
7.	It encourages collaborations and improves team spirit.	20	3.25	0.44	GA	3.15	0.49	GA
8.	It improves students' retention of knowledge and skills.	20	3.00	0.73	GA	2.85	0.67	GA
9.	It can improve students' academic confidence and boost morale.	20	3.25	0.44	GA	3.05	0.54	GA
10.	It can improve students' desire to study and learn.	20	2.85	0.37	GA	2.45	0.45	GD
11.	It can improve students' academic achievement better than lecture method.	20	2.85	0.88	GA	2.75	0.85	GA
12.	MQS is better than Lecture Method.	20	2.65	0.67	GA	2.70	0.73	GA
	Overall MRR	20	2.96	0.62	GA	2.88	0.66	GA

MRR = Mean Response Rating, SD = Standard Deviation, PD = Perceived Decision, GA = Generally Agreed, GD = Generally Disagreed

Table 1 presents the analyzed perceived response of Physics and KHE students to application of MQS in teaching and learning of Physics and KHE. As indicated by the table, all the students generally agreed that MQS is good for teaching and learning. To be specific, they generally agreed that: they like MQS, MQS can force students to be actively involved in learning activity, thus enhancing concentration and understanding and, is better than lecture method, but it makes learning too rigorous. They also agreed generally that MQS can improve: teacher-students and student-student interactions, students' intellectual thinking and reasoning, team spirit and encourage collaborations, students' retention of knowledge and skills, students' academic confidence and achievement better than the lecture method.

However, the salient aspect of this result is that Physics students generally agreed that MQS can improve students' desire to study and learn (MRR = 2.85) but KHE students generally disagreed (MRR = 2.45).

This may be because the KHE students got tired in the cause of learning through MQS as reflected in their perceived majority opinion that MQS makes learning too rigorous (MRR = 3.15)

Research Question 2: What is the effect of Modified Questioning Strategy (MQS) on academic achievement of students in Physics and KHE?

Table 2: Mean scores of Physics and KHE students in control and Experimental groups

	Physics		KHE	
Treatment	**MS**	**S.D**	**MS**	**S.D**
Control (LM)	15. 10	0.61	14.60	0.84
Experimental (MQS)	20.15	0.58	21.34	0.72

MS = Mean Score; SD = Standard Deviation; LM = Lecture Method

Table 2 shows the mean scores of Physics and KHE students in control and Experimental groups. From the table, Physics control and experimental groups have mean scores of 15.10 and 20.15, respectively while the KHE control and experimental groups have mean scores of 14.60 and 21.34, respectively. The table results reveal higher mean scores and lesser score variations for Physics and KHE groups taught by MQS than those taught by LM. This indicates that MQS improved students' academic achievement better than LM. MQS also showed lesser variations in score (SD = 0.58, 0.72) than those observed in LM (SD = 0.61, 0.84). Consequently, teaching and learning processes in the two courses based on MQS may have been improved.

Research Question 3: Does MQS influence students' academic achievement in Physics better than in KHE?

Table 3: Mean scores and group difference scores for Physics and KHE groups

	Control (LM) Treatment	Experimental (MQS) Treatment	
Course	**MS**	**MS**	**GS (%)**
Physics	15.10 (50.33 %)	20.15 (67.00 %)	5.05 (16.67 %)
KHE	14.60 (48.67 %)	21.34 (71.00 %)	6.74 (22.33 %)

MS = Mean Score; GS = Gain in Score; LM = Lecture Method

Table 3 shows the mean scores and gain in scores for Physics and KHE groups, under control and experimental treatments. From the table, Physics control and experimental groups have mean scores of 15.10 and 20.15, respectively, with a gain in score of 5.05 (16.67 %). Similarly, KHE control and experimental groups have mean scores of 14.60 and 21.34, respectively, with a gain in score of 6.74 (22.33 %). From the table results, MQS influence students' academic achievement in KHE better than in Physics with a gain in score of 6.74 (22.33 %) which higher than the observed gain in score of 5.05 (16.67 %) in Physics.

Research Hypothesis 1: There is no significant difference in the mean academic achievement scores of Physics students taught using MQS and those taught using Lecture Method (LM).

Table 4: t-test analysis results for Physics students taught by MQS and LM

Group	**N**	**MS**	**SD**	**Df**	t_{cal}	t_{table}	**P**	**Remarks**
Control	20	15.10	0.61					
Experimental	20	20.15	0.53	38	27.95	1.68	0.05	Significant

MS = Mean Score; SD = Standard Deviation

Table 4 showed the t-test analysis results for Physics students taught using MQS and LM. The results showed that t-calculated value (27.95) is greater than the t-table value (1.68) at 0.05 level of significance. Hence, the null hypothesis is rejected. This means that there is a significant difference in the mean academic achievement scores of Physics students taught using MQS and those taught using LM. In essence, Physics students taught using MQS and those taught using LM do not have equal academic performance. Based on mean scores of both groups, Physics students taught using MQS performed academically better than those taught using LM.

This observed result may be because MQS familiarizes the students with possible questions on the concepts of the study, get them involved in the solution processes (especially the formulae and calculation aspects) and eventually offer them the best solutions to the questions raised. This therefore placed them (students under MQS) in a better condition for examination and tests, compared to students under LM - who are taught by listening to the teacher's explanation of the concepts and sometimes with brief questioning, but without major participation in teaching-learning process and then prepare for examination and tests by reading and cramming the study notes.

Research Hypothesis 2: There is no significant difference in the mean academic achievement scores of KHE students taught using MQS and those taught using LM.

Table 5: t-test analysis results for KHE students taught by MQS and LM

Group	N	MS	SD	Df	t_{cal}	t_{table}	P	Remarks
Control	20	14.60	0.84					
Experimental	20	21.34	0.72	38	27.24	1.68	0.05	Significant

MS = Mean Score; SD = Standard Deviation

The results in Table 5 showed that t-calculated value (27.24) is greater than the t-table value (1.68) at 0.05 level of significance. This implied that there is a significant difference in the mean academic achievement scores of KHE students taught using MQS and those taught using LM, thus the null hypothesis is rejected. By implication, KHE students taught using MQS and those taught using lecture method do not have equal academic performance. Using the mean scores of both groups, KHE students taught using MQS performed academically better than those taught using lecture method.

Just like in table 4, this observed result may have being due to the conditioning effect of MQS which is great at exposing students to likely questions on concepts of study, get them involved in the solution processes and eventually offering the best answers to those study questions, thus training them ready for examination and tests. This is a situation students under the LM are not usually exposed to, instead they learn by listening to the teacher's explanation of study concepts and sometimes with brief questioning, without active participation in the teaching-learning process and then prepare for examination by reading the study notes.

Research Hypothesis 3: There is no significant difference in the mean academic achievement scores of Physics and KHE students taught using MQS.

Table 6: t-test analysis results for Physics and KHE students taught by MQS

Group	N	MS	SD	Df	t_{cal}	t_{table}	P	Remarks
Physics (Experimental)	20	20.15	0.53					
KHE (Experimental)	20	21.34	0.72	38	5.95	1.68	0.05	Significant

MS = Mean Score; SD = Standard Deviation

Table 6 results indicate t-calculated value of 5.95 which is greater than the t-critical value of 1.68 at 0.05 level of significance. Therefore, the null hypothesis is rejected. Thus, there is a significant difference in the mean academic achievement scores of Physics and KHE students taught using MQS. This implies that Physics and KHE students taught using MQS do not have equal academic performance and based on their mean scores, KHE students taught using MQS performed significantly better than those taught using LM.

This observed result may be due to the less difficulty nature of the concepts or topics taught in KHE class compared to the concepts taught in Physics class, which usually involves some abstract concepts, formulae and solving calculation problems, in addition to the read and write nature of the KHE topics.

Research Hypothesis 4: There is no significant difference in the mean perception ratings of Physics and KHE students concerning the use of MQS in teaching and learning of Physics and KHE

Table 7: t-test analysis results for students' perception of MQS in teaching and learning

Group	N	MS	SD	Df	t_{cal}	t_{table}	P	Remarks
Physics (Experimental)	20	2.96	0.62					
KHE (Experimental)	20	2.88	0.66	38	0.40	1.68	0.05	Not Significant

MS = Mean Score; SD = Standard Deviation

Table 7 showed the t-test results for students' perception of MQS in teaching and learning Physics and KHE. The results indicates that the t-calculated value (0.40) is lesser than the t-critical value (1.68) at 0.05 level of significance, hence no significant difference exists in the perception of the students concerning the use of MQS in teaching and learning of Physics and KHE. This means that both Physics and KHE students have similar or same opinion regarding the use of MQS in teaching and learning of Physics and KHE. Generally, they both agreed that MQS is good for teaching and learning of Physics and KHE, and that MQS is better than the common LM.

IV. Conclusion

The results obtained from this study revealed that: (i) MQS improved academic achievement of students better than LM, both in Physics and KHE. This was further stressed by the observed significant difference in the mean academic achievement scores of Physics and KHE students taught using MQS and those

taught using LM. (ii) Comparatively, MQS improves students' academic achievement in KHE better than in Physics. This result was again buttressed by the observed significant difference in the mean academic achievement scores of Physics and KHE students taught using MQS. (iii) MQS is good for teaching and learning as observed, based on responses from the study students.

V. Recommendation

1. Government and School authorities should organize workshops and seminars on application of MQS in teaching and learning, and sponsor their teachers to attend.
2. School authorities should encourage their teachers to teach using MQS, in addition to lecture method.
3. The Ministry of Education should provide to schools all necessary instructional and infrastructural facilities for effective application of MQS in teaching and learning.
4. Government, School authorities and other Stakeholders should put in more effort to improve teachers' remuneration, so that they can double their effort into ensuring that their teaching activities produce the best result.

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