Level 100 Physics' students' experiences and perceptions with interactive engagement approaches in teaching: a study in a Ghanaian University

[3]V. Antwi, R. Hanson, E. R. [4]Savelsbergh & H. M. C. Eijkelhof

Abstract

This article reflects on students' perceptions after interactive engagement (IE) approaches were used to teach them introductory mechanics in their first semester university programme. The intervention used was a means to improve students' critical thinking as well as promoting their participation in learning practice. This was done by dividing lessons into phases of activities that would stimulate students' intellectual engagement and make them participate fully in the teaching and learning processes. Students (N=20) were made to answer questionnaire items to ascertain their experiences and perceptions about the use of interactive engagement approaches on their learning. Crucial and important statements of students as related to the strengths and barriers of IE teaching from the transcription of interviews were clustered into themes. The themes reveal the perceptions of students with the use of interactive engagement approaches to teaching and how they have influenced students' learning. The results show that interactive engagement approaches promote learning and long retention of what has been learnt. It also promotes students' responsibility of their own learning, enhance students' interaction, interest by relating and explaining physics concepts to everyday activities, and makes them active in class. Important elements that could promote congenial implementation of interactive engagement teaching according to the perceptions of students are also discussed.

Keywords interactive engagement, teaching physics, learning physics

Introduction

Despite the increasing number of literature to make instructors use innovation in teaching devoid of the total or complete lecture method in the teaching of sciences, most instructors in many of the tertiary institutions in Ghana still use the "traditional lecture method", where students become the central repository of whatever the teacher says (Asunka, 2008). In most articles involving teaching and learning practices, the views, experiences and perceptions of students are usually not heard. Students' results from tests and questionnaires are usually analyzed to give conclusions of the outcome.

In this study, students' answers to questionnaire items and interview after the delivery of nine lessons planned with the use of interactive engagement (IE) approaches in teaching introductory mechanics were gathered and the outcomes published to see its effect on students' cognitive processing, attitude towards physics learning and their learning environment. The purpose of the study was to ascertain the perceptions of the students and to motivate teachers concerning the change from the traditional format to an

[3] Victor Antwi and Ruby Hanson are in the University of Education, Winneba, Ghana
[4]Savelsbergh & H. M. C. Eijkelhof are in Utrecht University, Netherlands

interactive engagement format as expressed in Churukian (2002). This is necessary as most literature in science education have mentioned the important role of students or learners engagement in promoting cognitive and social practice (Osborne & Wittrock, 1985; Hennessy, 1993; Goldberg, Otero & Robinson, 2010). Many educators believe that the traditional lecture approach to teaching is ineffective as compared to active learning methods (Marbach-Ad, Seal, & Sokolove, 2001; Jungst, Licklider, & Wiersema, 2003). According to Covill (2011), methods that promote active learning by students are based on constructivist view that, for meaningful learning to take place in students, they must actively engage with the to-be-learned subject matter through discussion, hands on activities and problem solving.

There has been a great mismatch between how we teach and how our students learn, and there is the need to shift our teaching style in science classes from teaching content to greater consideration of learning process (McDermott, 1993). With this approach, science educators and researchers would get the first hand information on the impact of the use of IE approaches on students' cognitive learning , social practice and how the phases of the activities used in interactive engagement approaches have contributed to students' conceptual understanding (Hake, 1998).

Methodology

First year physics students (both major and minor) were the subjects of this study. About three-fourth of these students came straight from the senior high school, at an average age of 19 years. One-fourth of the students had gone through the training colleges and polytechnics in Ghana before coming to the University of Education, Winneba, (UEW). The university is committed to the development of education in Ghana through the training of the teachers to feed all the levels of education in the country. This goes to show that current methods of instruction which have shown to be fruitful must be imbued in our students for onward transmission of knowledge wherever they may find themselves to teach after successful completion of the programme.

Nine lessons of interactive engagement approaches were planned in an introductory mechanics course for level 100 (2010/11 academic year) physics students in UEW. Each lesson was structured in such a way to promote students' interactive engagement and their understanding in concepts of mechanics. A lesson was divided into blocks with each block consisting of five phases of concept quiz, conceptual reasoning question, interactive teaching, reflection, and application question, for effective instruction. The concept quiz was usually part of the first block. A lesson was treated with students in each week for three credit hours. This was followed by a problem solving session, usually done fours days after the lesson. In this session, students solve selected qualitative and quantitative problems based on the lesson treated, so that they practice their level of understanding of the topics treated as proposed in (Cottle & Hart, 1996). Teacher supported students where necessary.

Questionnaire set up

Students in the 2009/10 year group answered questionnaire items in part (I) and (II). Questionnaire items are shown as appendix 1. The questionnaire was given to students by the teacher after the last lesson with students. Students were told in the previous week

about this exercise. They were allowed 30 minutes to answer the questionnaire after some explanations on it was given. All the 17 students were present and keenly supervised by the teacher.

Students in the 2010/11 year group answered the questionnaire items in part (III) as pre, as it was done before the beginning of the lessons. They were to reflect and consider situations for the three-year period that they were at the senior high school. This happened a week before the beginning of lessons. Twenty students answered the questionnaire on attitude towards physics teaching and learning environment scales, after some explanation had been given on the questionnaire by the teacher. They spent 20 minutes. They were all supervised by the teacher.

Again, students in the 2010/11 year group were made to answer part (I), (II) and (III) of the questionnaire after ninth lesson (i.e. last lesson) with the teacher. Part (III) of the questionnaire was referred to as post, as it was done after the completion of the lessons. They were to reflect and consider all the items as regards what occurred at the university. Students were informed about the exercise in the previous week before the completion of the lessons. All the 20 students took part and it was supervised by the teacher. They used 45 minutes for the completion of the exercise. The time was extended 15 minutes more than the time taken by the 2009/10 year group of students, due to some additional items in the questionnaire, part (III). All questionnaire items are shown in Appendix 1

Interview set up

An interview session was held for students to have their say on the approach used. The interview was used to add more value to the data on the questionnaire that revealed students' perceptions on the activities of the lesson, students' learning environment and the new teaching approach (interactive engagement approach). The interview and the questionnaire mutually reinforced each other, with the interview providing in-depth information on some of the responses in the questionnaire.

Students were interviewed after the end of all the lessons by a different lecturer. It was done four months after the end of the lessons. This long period was chosen to see whether students could still remember the IE approaches and its effect on them. The interviewer grouped all the twenty (20) students involved and asked the questions for students to respond. It was a face-to-face discussion between the teacher and the 20 students and happened in a relaxed and friendly manner where students could express whatever they felt. The interview questions followed a certain framework: The interviewer was to find students' view as regards two major issues; (1) strengths of the interactive engagement approaches used and (2) the barriers to applying interactive engagement approaches in teaching and learning of mechanics (physics). As regards questions which students found difficult to understand so as to be able to express their views, the interviewer had the opportunity to expand the questions to include more input as to why students held diverse opinion. Students' responses were recorded by an audio device. The interview session lasted for about 75 minutes. Interview guidelines are shown in appendix 2.

Results

Comparing students' perceptions on activities of the lessons

The 2009/10 group of students' perception on activities of the lessons was compared with the 2010/11 group of students. Year 1 refers to physics students in the 2009/10 academic year group, while Year 2 is for physics students in the 2010/11 academic year group. There were 17 students in the 2009/10 (Year 1) and 20 students in 2010/11 academic year (Year 2).

Table 1 Students' responses on activities of the lessons- 2009/10 & 2010/11

	Year	N	Mean	Std. Dev.	Sig. (2-tailed)	Std. Error Mean	Alpha reliability (∝) for year 1 & 2
1. Concept quiz	1	17	4.25	0.68	0.68	0.17	0.73
	2	20	4.34	0.72	0.68	0.16	
2. Conceptual reasoning question	1	17	4.59	0.60	0.44	0.15	0.89
	2	20	4.40	0.57	0.44	0.13	
3. Interactive teaching	1	17	4.18	0.69	0.32	0.17	0.89
	2	20	4.46	0.60	0.32	0.13	
4. Reflection	1	17	4.43	0.67	0.66	0.16	0.84
	2	20	4.51	0.57	0.66	0.13	
5. Application question	1	17	4.46	0.60	0.57	0.15	0.94
	2	20	4.56	0.51	0.58	0.11	
6. Problem solving	1	17	4.66	0.48	0.42	0.12	0.92
	2	20	4.51	0.62	0.41	0.14	

Students' perceptions on types of activities

From Table 1, it was realized that, there were no significant differences between the mean values (all mean values > 4) of the responses of the 2009/10 students and 2010/11 students. This shows that students in both year groups consented that all the scales had a positive influence on them.

Looking at the individual items within scales more closely and analyzing them, most students from both year groups perceived that the short quizzes helped them to do their reading assignments before coming for lectures; the conceptual reasoning questions helped them to express their own ideas; the interactive teaching helped them to get thorough understanding of the topics in "blocks" within lessons; reflection enabled them to give more satisfying and elaborate answers to the starting questions; application questions helped them to gain confidence in practicing and applying what had been learnt; and problem solving helped them to understand deeply how problems in mechanics were solved, and so solved questions on their own. They further agreed that they did enjoy all the activities mentioned, as they helped them to participate actively in class and to understand concepts of mechanics. From students' responses, they did like all the activities used in the lessons, found them useful and were positive towards it.

Comparing students' perceptions on attitude and learning environment scales

Students in the 2010/11 year group were made to answer *pre* and *post* questionnaire on items on attitude and their learning environment. Students' responses were compared to see if there would be any significant differences in their mean values. *Pre* indicates students' response to the pre questionnaire, while *post* shows students' response to post questionnaire. Thus *pre* is the reflection of students' position on physics teaching and learning environment at the senior high school (SHS- a three-year programme), and *post* is the reflection of students' position after the completion of the first semester physics course at the university.

Table 2 Students' mean scores of their attitude towards physics teaching and learning environment before and after the intervention

	Pre/Post	N	Mean	Std. Dev.	Sig. (2-tailed)	Std. Error Mean	Alpha reliability (∝) for Pre & Post
1. Students' attitude towards physics teaching	Pre	20	4.14	0.98	0.50	0.22	0.72
	Post	20	4.31	0.80	0.50	0.18	
2. Students' cohesiveness	Pre	20	4.18	0.81	0.51	0.18	0.75
	Post	18	4.28	0.66	0.51	0.15	
3. Instructor's support	Pre	20	3.78	0.99	0.49	0.22	0.87
	Post	20	3.97	0.64	0.50	0.14	
4. Students' cooperation	Pre	20	4.27	0.62	0.47	0.14	0.90
	Post	20	4.39	0.67	0.47	0.15	

Students' perceptions on attitude towards physics teaching and learning environment

From Table 2, there was no significant difference between pre and post of their mean values. Thus, students' mean values of pre and post responses on attitude towards physics teaching, cohesiveness, instructor's support and students' cooperation were about the same. From students' responses, both methods employed in teaching at the SHS and at the university level had almost the same effect on their attitudes towards physics teaching and learning environments; the only exception being the mean values of scales at the university level. These were slightly higher. Thus students perceived all the scales to have similar effect on their attitudes towards physics teaching and learning environment in both senior high school and the university level.

Looking at individual items more closely and analyzing them it turned out that students were not sure whether lessons in physics were fun at the SHS level. However, they agreed that physics lessons in class were fun at the university level. Again, students acceded that the instructor at the university talked to them more than was done at the SHS level.

Students' perceptions revealed by interviews

The interview was used to add more value to the data on the questionnaire that revealed students' perception on the activities of the lesson, students' learning environment and the new teaching approach (interactive engagement approach). The interview and the questionnaire mutually reinforced each other, with the interview providing in-depth information on some of the responses in the questionnaire. Crucial and important statements of students as related to the strengths and barriers of IE teaching from the transcription of interview were clustered into themes. The themes revealed the perceptions of students with the use of interactive engagement approaches to teaching and how they have influenced students' learning. The following are the themes (A to L) and the descriptions of students' perceptions:

A. Self finding

- I had to visit the net and solve a lot of problems,…
- …, we realized that there were some forces that are fictitious ....
- I realized that physics was not only emm …, a course based on calculations, but real happenings around us but real happenings around us.
- When I was taking a stroll around I was observing some things around me then relating them to the things that we learnt, …
- When I compared the physics I learnt in the secondary school and here, there is a far difference, because at the secondary school level I can't use physics to explain real life situations, but at the end of the semester here, I was able to use physics to explain real life situation. .., a car travelling,… football

Students perceived that the interactive engagement approach made them find answers to questions on their own, became good observers of their environment and explained things in their surroundings by relating them to what they learnt in class. Thus, they could transfer the conceptual knowledge gained to explain similar but new situations in their environment. They became self dependent in terms of solving problems as they could easily apply the knowledge gained understandably.

B. Awareness of some misconceptions

- Two bodies of different masses are free-falling,… back at SS, I never had that concept, but here … I realized that concept …
- …, monkey and the banana *(using gravity to determine the line of throw)*
- …, clashing of the cars *(formerly thinking of the bigger car to exert greater force)*
- Arnold the strongman *(thinking that Arnold would exert greater force on the rope because of his bigger mass)*
- …, clashing of the fly on the windscreen. *(The windscreen of the bus will exert greater force on the fly than the fly would exert on the bus…)*
- … we realized that there were some forces that are fictitious. *(Referring to centrifugal force in circular motion)*

- …, acceleration due to gravity, *(thinking that acceleration due to gravity should always be positive due to its attraction of objects towards the earth).*
- At times people do say that they have done work, when … an object had moved through a distance, but I realized that when an object moved through a distance and the force is perpendicular to the distance, no work is done, because the angle between them is 90°, and $Cos90^{o}=0$.
- …, forces are equal and opposite *(in a collision between two objects irrespective of their masses)*, *like,* articulator trucks and the small trucks…, equal effect on each other.

Students became conscious of some misconceptions which they carried from the senior high school. They perceived that the interactive engagement approach had broadened their perspectives and could now establish the proper concepts in mechanics. For example, some thought the object with the bigger mass would always exert the greater force in a collision with an object with a smaller mass, even though they could recite Newton's 3rd law accurately. They considered "work" to be done any time a force caused displacement of an object, without any regard to the cosine of the angle between the force and the displacement.

They had better understanding of concepts after interactive engagement and could realize why a force like centrifugal is fictitious. By the use of interactive engagement approaches students were able to realize misconceptions themselves.

C. Retention and concentration

- … the interactive approach has helped especially in the concentration,…, without feeling that we've been here for such long hours.
- ..., in terms of retention, because we interacted with some materials, recollecting those things was not difficult for us. Even up to date, some to the demonstrations, I still have them as if they were just yesterday instead of the abstract teaching type. So the interactive was very helpful.

Students became conscious of the fact that the interactive approach was a key to their retention of what had been learnt or experienced. Their notion was that, once they interacted with some of the materials, it was quite easy to recollect the mental picture that had been created on their minds.

They also saw the approach as a means of gaining control over boredom in class. They felt that as they were always active, interacting with their peers, teacher, microcomputer laboratory tools, animations and pictures, they could stay for long hours without losing concentration.

D. Cooperative and hard work among students

- … we go round and do our own research, and the assignment … was helping us to do more research.
- We call one another,…
- It made us to be more …cooperative to one another …
- We were able to study in groups
- … and we helped one another.

- So he made us to work hard every time and every day,

Students perceived that interactive engagement promoted cooperation among students ss they held numerous discussions in groups during lessons. They were able to study in groups to discuss assignment problems, share ideas and help each other. They were able to go round on their own to search for their own information to solve assignment problems as well. This of course made the students to be hard working as everybody was given a role to play in researching to get the right solutions.

E. Time consuming nature of workload

- … comparing to other courses that we were doing, we realized that this was a little loaded.
- …, he gave us a lot of work
- …, when you consider the volume of work you were doing in physics and the time it was taken, on the average, it was taking much more time.
- It wasn't enough, but it challenged our thinking abilities to be more smart and fast in thinking so that we would be able to catch up within the stipulated or the allowed time frame …
- … it is really time consuming.
- You will be on it throughout the night, … we are tired and exhausted.
- We spend more time than the usual time.

Students felt that the work was loaded, especially when they compared the volume of work to other courses. They thought that they were assigned to do more work in the course.

Again, students saw some tasks like working on projects to give presentation in class and solving assignment problems to be time consuming. These usually required great effort before they could be accomplished. They were very exhaustive and tiring as they usually had to spend more time to work. However, they asserted that the time allotted for group discussions on conceptual reasoning questions and application questions was not enough; hence they had to be fast and smart in their thinking abilities to work within the allotted time.

F. Time worthy

- So it was not a waste of time.
- we using more than the 3 stipulated hours is not due to the lesson but rather sometimes the arguments and then some of the questions we bring due to the misconceptions that we are carrying.
- He gives us the chance to go out for a walk and the break …
- sometimes to clear misconceptions we brought from our various schools.

Students realized that though more than the stipulated time was spent on some lessons, it was worth it. Thus the quality of questions and how they influenced students' learning rendered the extra time spent on some occasions to be desirable and useful.
On the other hand, others attributed more time spent to the break periods, explanations of misconceptions and prolonged arguments by them.

G. Benefits of IE teaching methods

- … if we are to acquire it at the secondary and the primary level we shouldn't have found physics difficult,
- I will go for the interactive approach but only with the situation that the materials to give out these methods are available,
- …, it explains the thing better and the concepts are clearer. Unlike the other one that you are forced to memorize or you just forget about it,… you keep whatever is given to you and you reproduce, without following the actual this thing
- … not to be inactive in class or passive in class.
- When that method of teaching is being used it makes everybody active, so that everybody will give his or her quota to what we are doing.
- …, interactive approach is good because it also removes fear from the students.

Students perceived the interactive engagement teaching to bring a lot of benefits. These included the fact that it explained concepts better and clearer. Everybody in the class was actively involved in what was going on. It also removed fear. Students who were afraid to talk initially in the presence of their colleagues were able to do so later. Students were also convinced that the IE approaches were better means of committing things to memory than the traditional lecture approach where one was under duress to memorize and reproduce what has been given him without any better understanding.

H. Teacher's IE evaluation

- My general overview is that the lessons have been very good. If all lecturers would take that approach, I think it will go a long way to impact positively on us.
- And also the lesson has also been a very, very successful one, because we see that *the teacher* was the type who has a lot of time, because we see some lecturers who have to take us for three hours but the lecturers would not do that three hours.
- My physics understanding had really gone up because at first, I was having many misconceptions about certain concepts in physics but after the whole lessons or after the semester, mechanics, many of the concepts were understood. And my cognitive thinking about certain things improved.
- *The teacher* did a very wonderful job for us.
- He made us to continue to be proud, even as you *(interviewer)* called us for this interview, in fact, everybody was, as you can realize, everybody is willing to contribute, and I think, I think he is wonderful, and we only want to encourage him to keep it up and never regret using the approach he has been using to teach.
- He understood us.

- …, but through the use of animations and some explanations, I was able to understand the concepts well.
- …, especially on the projectiles
- … was really imparting a whole lot of knowledge and the concepts, especially on the projectiles, because I realized that he did a whole lot of diagram… animations and that animations really helped us.
- …, he sometimes used pictures to explain situations,…
- ...the way he leaves interactive questions on board, that we should research, …. That makes us come out with the various suggestions, agree and disagree with each other to come out with the facts.

Students saw the approach used by the teacher to be good, and were quite positive that, if other lecturers would adopt the approach, it would impact positively on their learning. They were of the view that, the teacher utilized the time to their benefit, unlike other lecturers who would not use the three hours allotted them to the full.

Students confirmed that their conceptual understanding and cognitive processes in mechanics had improved after the use of IE teaching of the lessons. They went further to encourage the teacher to keep it up and never regret with the use of the IE approaches in teaching.

They saw the teacher to be more approachable and understandable. They asserted that the use of animations, diagrams, pictures and explanations which were relevant to real life situations helped them to conceptualize. Group discussions and plenary sessions, various suggestions and arguments were crucial elements to make understanding of facts quite successful.

I. Learning under pressure

- …, some of us are the types who are able to learn under pressure. And he provided this pressure on us.
- So he made us to work hard every time and every day,
- And you will see that the quiz will force you to learn …, and you will be very tired.
- the number of assignments that you have to take home… I am thinking that perhaps the assignment forced you to read.
- Madam, you are answering for us…
- In fact, he assumed we were not having group studies, but it made us even to stay at the language department *(one of blocks where students go to study in the night)*, and then go through the questions.

Students perceived that the quizzes, assignments, teacher-student and student-student interactions, as well as the questioning skills of the teacher provided the necessary pressure on them to work harder. They conceived that because some of them were the

types who learn under pressure, the interventions put in place contributed to the hard work they put in on daily basis. It improved their learning habits.

J. Students' recognition

- Actually, the way he took keen interest in all of us. Sometimes he knew all of us by our surnames and our Christian names. He knows every student by his name, unlike other lecturers, who were just the type that come to class, got to the class and then they are off. He knows us by names.

Students agreed that acknowledging and calling them by their names was a clear indication of the teacher's keen interest in them. They compared this situation to other teachers whom they thought were not concerned about them because they did not mention their names in class. This goes to show that knowing and calling students by their names is a motivation which should not be downplayed by any teacher.

K. Teacher as a role model

- Actually, *the teacher* had done, had had a positive impact on me and personally, I have adopted his method of teaching and I have made…
- Yes, that is how I want to be as I will become a teacher in the nearby future. So I really thanked him for…
- I will use that method because it makes the understanding of the concepts very easy. Because when you get the picture, most of us are able to get concepts based on pictures and animations. And he combined these things in his lessons delivery. And that what makes the understanding very easy. That is why I will go in for that method.
- and with his teaching I have adopted it. If God permits and I am able to go through, I will behave like him.
- So I will say that method that *the teacher* used is correct and the best one of course.

The students saw the teacher as a role model for them to emulate. They promised to adopt the teacher's style in behavioural, social and teaching method in the near future when they also became teachers. They attested to the fact that the teacher's method (IE method) used in teaching them was the best and most appropriate one.

L. Less contribution in class

- some of us have not got a very good physics background.
- because like me for instance, I was having some problems at the SS
- but because you have a very bad handwriting, you are even afraid of the white board.
- some of us are enemies of the public, so since you are not in that mood to talk after writing you will be scared to go there
- some of us, at times were not well prepared before coming, so when the questions come that way, you find it difficult to go and do it on the board
- sometimes or let me say that *the teacher* one day used, …, negative words,… So since then I was afraid to come out.

Students emphasized that some of them could not contribute well enough in class due to their poor physics background and ill preparation before the lessons. Some of them were also of the view that they found it difficult to talk in public or in front of their peers; hence could not contribute enough in class. Others also mentioned that their bad handwriting on the board prevented them from solving problems on the board.

Some claimed that the use of negative comments on students' contributions, especially by the teacher could serve as a means of inhibiting students to come out with their views in class. They felt intimidated and did not present their views in subsequent discussions.

Conclusions

In conclusion, it was realized that most of the things that students said in the interview supported their responses in the questionnaire. They perceived that the activities did help to express their own ideas, gain confidence in doing their reading assignment, practicing as well as applying what had been learnt. They were of the view that it promoted their learning engagements, such as concentration, thinking, discussion, cohesiveness and cooperation. Similar results are shown in Chang, Jones and Kunnemeyer (2002).

Again, students' mean values of the pre and post responses on attitude towards physics teaching, cohesiveness, instructor's support and students' cooperation were about the same. This was however contradictory to what Martin-Dunlop and Fraser found. In their case, students reported large and statistically significant improvements on all the scales used in assessing the laboratory learning environment and attitudes towards science, (Martin-Dunlop & Fraser, 2007). Students positive attitude towards senior high school teaching as well as the new method used at the university could be ascribed to the following reasons:

- The physics students were a selected group of students who had opted to become physics teachers and they enjoyed physics irrespective of the method used.
- Students wanted to please the teacher by giving him such high results for the teacher to like them also.
- Students could be classified as "positive buyers" due to cultural biasness. Thus they are always positive to all situations. They thought that being negative is a sign of being disrespectful, even if the situation demands that.
- Fear of victimization could be another reason. Being negative could subject students to bitter experience which might affect their course of study.

The lecture method was mostly used to teach students for three consecutive years at SHS towards which the students were positive. It was therefore surprising to see students accepting and showing more positive attitude towards the introduction of this completely different method of teaching (interactive engagement method). With the inclination of students as well as teachers to maintain the existing or traditional order; tending to oppose change, it was expected that students would have rated the new method quite low,

but this was not the case. Despite their conservative values, they rated the new method of IE used at the university a little higher than the traditional approach used in SHS.

Also, the results of the analysis on the questionnaire on the effect of the use of the new approach at the university and the traditional approach at the SHS on students' attitude towards physics and learning environment were surprising in the sense that it was quite different from the interview session. In the interview students perceived that the IE approaches impacted more positively in their attitudes towards physics teaching and learning environments than the traditional methods used the in senior high schools. In the questionnaire the students rated both cases at almost the same level.

One would have thought that students would misconstrue the work load and time consuming nature of presenting projects, assignments and concept quizzes as negative. However, they interpreted and accepted them positively by explaining that it put on them the necessary pressure to learn. They also enumerated some of the crucial roles the IE approaches had on their learning as; it encouraged them to search for their own information- making them responsible for their own learning, it helped in explaining concepts better and clearer, and made everybody participate in class. Again, it removed fear from students, especially those who were afraid to talk in front of their peers. This new approach enabled them to commit things to memory easily. They were able to recall in times of need without any difficulty. Their social interactions were enhanced as they could work cooperatively with each other.

The fact that there were not many complaints about the use of this method in teaching showed that students did not oppose to it. They perceived physics to be more interesting now than in the past, in the senior high school. Their views on physics changed conceptually. They were able to relate many examples to daily life activities.

The study has gone to prove that, the use of interactive engagement approach in teaching at the university is feasible under the same restricted teaching resources and students' situations as it is in the traditional lecture method. Nevertheless, creating the right, demanding and safe atmosphere, where students would feel free to express their ideas was a strong case for making students to come out with commendable statements on the use of IE approaches and how it affected positively on their learning.

Important elements for interactive teaching according to the perceptions of students

Despite the positive experiences with the use of the interactive engagement approaches, the following elements are regarded as important for interactive teaching for teachers who would like to implement interactive engagement approaches in their teaching to consider. Optimum benefits could be achieved by both teachers and students. These elements are derived from the perceptions which students had on the use of interactive engagement approaches used.

- In order to work within the stipulated time in class, teacher should encourage students to write down their questions for it to be discussed at the tail end of every lesson. This is due to the fact that most of the students' questions are answered in the process of teaching and discussions within a lesson.
- Teacher should develop good conceptual reasoning questions and sharpen his or her questioning skills. These would encourage students to talk to let the teacher know the misconceptions they carry to the class and their level of understanding as well.
- The full participation of the students in the interactive-engagement usage depends also on the positive classroom atmosphere. All efforts by the teacher to produce a rightful and demanding atmosphere devoid of any antisocial conducts in the class should be used to encourage, get students' confidence of participating and contributing freely. A good rapport between the teacher and students usually encourage maximum students' participation.
- Teachers and students sometimes ridicule their colleagues when they provide ludicrous answers. This sometimes daunts the student's spirit to such an extent of not participating anymore in class. Teachers and students should be entreated to desist from laughing at their colleagues by providing wrong or bad answers. Reasons should be given to students why they should desist from such practices.
- Teachers should note that joking with students sometimes is risky. However, it could be helpful for a good class climate to help interactive teaching, especially in situations that would allow students to elaborate their wrong ideas without fear. Expensive jokes that would endanger the reputation of the students should be avoided.
- Students perceive by most members to be knowledgeable within a group will be doing the talking always. It is therefore important to take steps of avoiding such practices. Teacher could adopt the style of calling any member within a group to give the group's response. In so doing all students will give special attention to the group's discussions.
- Teacher should as a matter of urgency learn and call students by their names. This would make them feel recognized as being part of the class and contribute their quota effectively to the class activities.
- The teacher should be very approachable and understandable. He should be seen as friendly as possible for the students to put their confidence in him. Once they entrust their confidence in you as the teacher, they come out and participate well in all interactions.
- It could be time consuming both in its preparation and implementation in the classroom, especially if the teacher's preparation before the lesson is not adequately enough. Therefore the teacher has to prepare adequately before the start of the lessons. His lesson notes, preparation of power points slides (if

available) and the demonstrational or teaching materials should be fully prepared in advance. Fortunately there are numerous assist from the internet and books with already made questions, simulations and animations which the teacher could browse and use.

References

Asunka, S. (2008). Online Learning in Higher Education in Sub-Saharan Africa: Ghanaian University students' experiences and perceptions. *The International Review of Research in Open and Distance Learning*, **9** (3), 1-13.

Chang, W., Jones, A., & Kunnemeyer, R. (2002). Interactive Approach in Year One University Physics in Taiwan: Implementation and Evaluation. *Asia-Pacific Forum on Science Learning and Teaching*, **3** (1), 1-23.

Churukian, A. D. (2002). *Interactive engagement in an introductory university physics course: Learning gains and perceptions*. Thesis, (Ph.D.). Kansas State University, Manhattan K. S.

Cottle, P., & Hart, G. (1996). Cooperative learning in the tutorials of a large physics class. *Res. Sci. Ed.* **26** (2) 219-231.

Covill, A. E. (2011). College Students' Perceptions of the Traditional Lecture Method. *College Student Journal*, **45**, (1), 92-101.

Goldberg, F., Otero, V., & Robinson, S. (2010). Design principles for effective physics instruction: A case from physics and everyday thinking. *American Journal of Physics*, **78** (12), 1265-1277.

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, **66** (1), 64-74.

Hennessy, S. (1993). Situated cognition and cognitive apprenticeship: implications for classroom learning. *Studies in Science Education*, **22**, 1-41.

Jungst, S., Licklider, B., & Wiersema, J. (2003). Providing support for faculty who wish to shift to a learning-centered paradigm in their higher education classrooms. *The Journal of Scholarship of Teaching and Learrning*, **3**, 69-81.

Marbach-Ad, G., Seal, O., & Sokolove, P. (2001). Student attitudes and recommendations on active learning. *Journal of College Science Teaching*, **30**, 434-438.

Martin-Dunlop, C., & Fraser, B. J. (2007). Learning Environment and Attitudes Associated with an Innovative Science Course Designed for Prospective Elementary Teachers. *International Journal of Science and Mathematics Education*, **6**, 163-190.

McDermott, L. (1993). How we teach and how students learn- A mismatch? *American Journal of Physics*, **61** (4), 295-298.

Osborne, R. J., & Wittrock, M. (1985). The generative learning model and its implications for science education. *Studies in Science Education*, **12**, 59-87.

Appendix I

Questionnaire for students

"All information is confidential and will be treated as such".

I. **Code:** *Birthday* _ _ *Month* _ _ *Last 4 digits of your mobile phone number* _ —

Sex:.....
Age:.....
SHS or SSS attended:…….
Which city or town is the SHS or SSS you attended located? ……
Urban or Rural:……
What was your grade in physics (WASSCE or SSSCE)?…….

Items in students' opinions about the types of activities used in the lessons.

II. A five-point Likert scale questionnaire with responses ranging from strongly disagree SD (1), disagree-D (2), not sure-NS (3), agree- A (4), and strongly agree-SA (5), is used.

A. Short Quizzes

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
11. Helped me to do my reading assignment before coming for lectures.					
12. I enjoyed this activity					
13. Helped me to participate actively in class.					
14. Helped me to understand mechanics concepts.					

B. Conceptual Reasoning Question

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
15. Helped me to express my own ideas.					
16. I enjoyed this activity					
17. Helped me to participate actively in class.					
18. Helped me to understand mechanics concepts.					

C. Interactive Teaching

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
19. Helped me to get thorough understanding of the topics in "blocks".					
20. I enjoyed this activity					
21. Helped me to participate actively in class.					
22. Helped me to understand mechanics concepts.					

D. Reflection

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
23. Enables me to give a more satisfying and elaborate answer to the starting questions.					
24. I enjoyed this activity					
25. Helped me to participate actively in class.					
26. Helped me to understand mechanics concepts.					

E. Application Questions

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
27. Helped me to gain confidence in practicing and applying what has been learnt.					
28. I enjoyed this activity.					
29. Helped me to participate actively in class.					
30. Helped me to understand mechanics concepts.					

F. Tutorial

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
31. Helped me to understand deeply how problems/questions in mechanics are solved, and can solve questions on my own.					
32. I enjoyed this activity.					
33. Helped me to participate actively in class.					
34. Helped me to understand mechanics concepts.					

III. Items in Attitude & Learning Environment Scales (Pre and Post
"All information is confidential and will be treated as such".

Code: *Birthday* _ _ *Month* _ _ *Last 4 digits of your mobile phone number* _ _

A five-point Likert scale questionnaire with responses ranging from strongly disagree-SD (1), disagree-D (2), not sure-NS (3), agree- A (4), and strongly agree-SA (5), is used.

G. Attitudes towards physics teaching

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
35. I looked forward to (eagerly anticipate) physics lessons.					
36. Lessons in the class were fun.					
37. I disliked lessons in the class. **R**					
38. Lessons in the class bored me. **R**					
39. The class was one of the most interesting university classes.					
40. I enjoyed lessons in the class.					
41. Lessons in the class were a waste of time. **R**					
42. The lessons made me interested in physics.					

H. Students' cohesiveness

	SD (1)	D(2)	NS (3)	A (4)	SA (5)
43. I made friends among students.					
44. I knew other students.					
45. I was friendly to other students.					
46. Other students were my friends.					
47. I worked well with other students.					
48. I helped other students who were having trouble with work.					
49. Students liked me.					
50. I got help from other students.					

I. Instructor's support

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
51. The instructor took a personal interest in me.					
52. The instructor went out of his way to help me.					
53. The instructor helped me when I had trouble with the work.					
54. The instructor considered my feelings.					
55. The instructor talked with me.					
56. The instructor was interested in my problems.					
57. The instructor moved about the class to talk with me.					
58. The instructor's questions helped me to understand.					

K. Cooperation

	SD (1)	D (2)	NS (3)	A (4)	SA (5)
67. I cooperated with other students.					
68. I shared my books and resources with other students when doing assignments.					
69. When I worked in groups, there was team work.					
70. I worked with other students on projects.					
71. I learned from other students.					
72. I worked with other students.					
73. I cooperated with other students on class on class activities.					
74. Students worked with me to achieve class goals.					

Fill in comments, hints, and suggestions

……

Appendix II

Interview Guidelines

1. **Strengths of the interactive-engagement approaches used (e.g. the use of Microcomputer based laboratory tools (MBL), animation, group discussion, teacher-student interaction, student-student interaction, presentation, the use of white board (for explanation or solving of problems), problem-solving session (tutorial), conceptual reasoning questions, application questions, etc.**
   - *Cognitive processing:* That is how the interactive engagement (IE) approaches had promoted their engagement in thinking about mechanics concepts (physics concepts).
   - How could they compare their thinking in mechanics concepts after the use of the interactive engagement approaches with their learning experience in secondary schools? What about Newton's laws of motion and understanding of graphs?
   - *Concentration and retention:* That is how the interactive engagement approaches had been beneficial to concentration and retention of mechanics concepts in class. In what ways had the use of these IE approaches contributed to your concentration and retention of mechanics concepts in class?
   - *Identification of misconceptions:* That is how the IE approaches had provided opportunities for them to understand some mechanics concepts (physics concepts) and helped them to identify the misconceptions. Students can give specific examples of their misconceptions and how the use of IE approaches had helped them to identify that they were misconceptions.
   - *Shifting focus from teaching to learning:* That is whether the use of IE approaches had shifted the focus of teaching from the teacher and teaching materials to the learners (students) and learning outcomes.
   - *Teachers as learning facilitators:* That is whether the students felt that the teacher (lecturer) was lazy by using the teaching time for students to work by themselves instead of teaching or lecturing them.
   - Did they see the teacher to be committed in helping the students to learn? In what ways?
   - Was the time giving to them to think was worthwhile? In what ways?
   - *Harmful to content coverage:* That is whether the students saw the IE approaches could be harmful to content coverage or not (whether all the content in mechanics would be covered)? In what ways?
   - *Teach less and learn more:* That whether the students felt that the IE approaches were making the teacher to teach less while the students think more or not? In what ways?
   - Did the students see the interactive activity to be a waste of time? In what ways?
   - How do students compare IE approaches with traditional lecture method in class?

2. **Barriers to applying interactive engagement (IE) approaches**
   - *Insufficient physics background:* That is whether their insufficient physics background was not making them to contribute enough with their colleagues or to answer questions in class.
   - *What about the reading assignments and short quizzes:* Were they not helping them to read ahead and contribute? In what ways?
   - *Being afraid or being blamed or teased by the lecturer or peers:* That is whether students were afraid to expose their weakness in front of their colleagues/peers and the teacher. Was that the reason why they were not contributing in class?
   - *Lecturers difficulty in understanding students difficulties:* That is whether students felt that because lecturers have high level of academic achievement, they could hardly understand where they are at, and that was why they were keeping things to themselves instead of asking the lecturer.
   - *Time consuming:* Did the students see the IE approaches to be time consuming? Was the time consuming worthwhile? In what ways?