Interactive Teaching Approach in Year One University Physics in Taiwan: Implementation and Evaluation

Wheijen CHANG

Physics Teaching and Research Center, Feng-chia University, Taiwan

Email: wjchang@fcu.edu.tw

Alister JONES

Centre for Science and Technology Education Research,

University of Waikato, New Zealand

Rainer KUNNEMEYER

Department of Physics and Electronic Engineering

University of Waikato, New Zealand

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Contents

Abstract

We report on the design and outcomes of an intervention teaching program that was implemented in a tertiary physics class in Taiwan. By providing the students with context-rich questions and sufficient time for thinking and discussion, the program aimed to stimulate students' intellectual engagement and intended to promote their participation in learning practice. The program was assessed by interviewing students (N=14) as well as by surveying the students' opinions in confidential questionnaires (N=380). The results indicate the successful nature of the program in terms of promoting engagement in learning situation, students taking more responsibility for their learning and promoting interest and enjoyment in learning physics. However, there was no evidence to suggest an improvement in traditional tests.

Introduction

Despite the burgeoning literature on innovation in tertiary science education in recent decades, in Taiwan, the instructional methods of many science classes have remained unchanged and dominated by the traditional didactic teaching. This type of teaching approach appears in most of the year one university physics as well as high school physics classes. In both high school and tertiary classrooms, physics teachers' major tasks involve describing physics principles, demonstrating mathematical skills, and working through textbook exercises, while the students' tasks are limited to listening and copying notes.

The literature in science education has indicated the crucial role of learners' engaging in cognitive processing[1] as well as to participate in social practice[2] when learning physics, and thus challenges the traditional didactic teaching approach. Both constructivist and sociocultural views of learning suggest that the focus of science classes should shift from teaching content to a greater consideration of the learning process. As McDermott (1993)[3] summarized from many studies in physics education research:

> Teaching by telling is an ineffective mode of instruction for most students. Students must be intellectually active to develop a functional understanding. (p.297)

A teaching approach, which provides time and questions for students to think and discuss, and which cultivates a supportive classroom atmosphere to promote interactions between students and the teacher, and amongst peers, was found to be crucial to promote learners' intellectual engagement in class[4]. This type of teaching approach is defined as *interactive teaching* in this study, in contrast to the more uni-directional delivery type of instruction typified by didactic teaching.

In the context of first year university physics courses in western countries, many studies have adopted an interactive teaching approach and found that it promotes students' participation in the learning process, and is beneficial to the students' performance[5]. However, most of the studies have focused on the evaluation of academic performance[6], and very few studies have explored the students' affective learning outcomes and their perceptions of learning[7].

The literature in science education highlights that students' perceptions of learning is influential to their learning focuses and strategies[8]. In the context of university physics, several studies have investigated the students' epistemological beliefs of how and what to learn[9]. However, these studies mostly investigated students taught with a traditional teaching approach in western countries. There appears to be a lack of studies exploring students' perceptions of learning and teaching in the context of Asian countries, particularly when taught with an interactive teaching approach.

The purpose of the study presented in this paper was to compare the learning outcomes of classes taught with an interactive teaching approach and those taught with a traditional didactic teaching approach in year one university physics in Taiwan. A wide scope of learning outcomes was examined, which included academic achievement, affective outcomes, and perceptions of learning.

Background of the Research

A brief introduction to the background of this study is provided.

The subjects of this study were first year physical science and engineering students at Feng-chia University in Taiwan, a large, private university, where about 2000 students enroll in this course each year. The students' average academic level at Feng-chia University is located around the medium for all university students in Taiwan, but their physics backgrounds were widely spread in one class. The classes are grouped according to the students' majors, and the same group of classmates meets in the same classrooms for most of the courses in the first year of study. Most of the students, come straight from high school, are of similar age and had similar study experiences.

It has been found that the Taiwanese students, on average, have studied more hours of physics in high school, and are equipped with stronger physics backgrounds than their peers in the USA, when entering university[10]. In addition, it was found that most of the incoming students possessed positive learning attitudes and had high expectations towards the new stage of studying at university[11]. Depressingly, the positive attitudes towards learning were found to deteriorate markedly right after their first year university study commenced, which included the willingness of attendance and the adoption of superficial learning strategies[12].

As in many other countries, university physics courses are a requirement for all science and engineering students. At Feng-chia, this is a two-semester course where each semester consists of 15 weeks. Two different courses are taught, one based on 2hr/wk and the other on 3hr/wk. Our study is limited to the latter, which is more common at Feng-chia as well as at other universities in Taiwan. Unlike many other countries, there is no tutorial session for this course. The course textbooks are selected from the USA version of conventional textbooks[13], which appear to be extremely heavy with regard to the available teaching time

The lecture classes are usually attended by about 55-65 students, sitting in rows, side by side, facing the lecturer. This seating arrangement is suitable for traditional lecturing, but may impede interaction amongst peers.

Methodology

Our study included three steps: 1. the design of an intervention teaching program which modified the traditional lecture using an interactive teaching approach; 2. the implementation of the intervention program, and 3. the evaluation of the learning outcomes of the intervention teaching program in comparison with those of the traditional lecturing.

- ***Design of an interactive teaching program***
  The strategies and the design details of the intervention teaching program (ITP) are based on the current literature of science education and our understanding of the existing situation of university physics education in Taiwan. They can be described as follows:

In each lecture (50 mins), the ITP provided the students with 4-7 concept questions and sufficient time to think about and discuss these questions.

For example, in one unit the lecturer/researcher started by presenting the OHP transparency shown in Figure 1 and was looking for the corresponding concepts that explained why the man lying down could survive the impact. A concept question was then posed to the students:

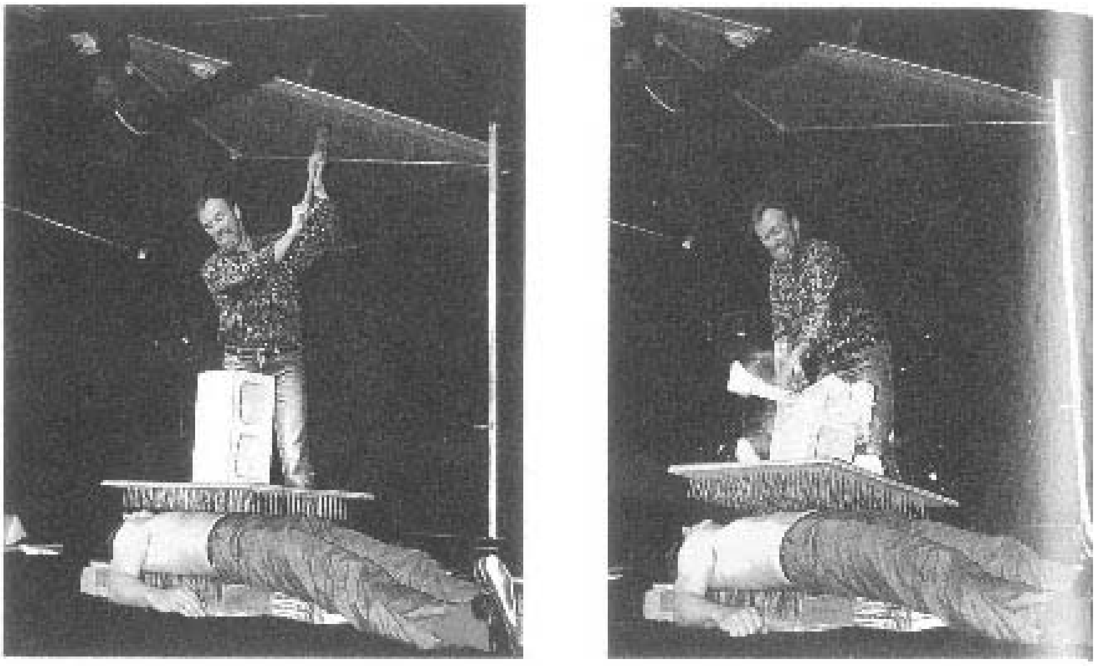

Figure 1 An OHP transparency for concept test (Hewitt 1998)

Which physics quantity was conserved during the action? (a) energy, (b) force, (c) momentum (Epstein, 1983)[14].

The students were then asked to think about the problem individually, to discuss with their neighbours, and then discuss with the whole class. During the whole-class discussion, the lecturer went through each alternative, and the students raised hands to indicate their selections. A few students then volunteered an explanation of the reasons for their selections. After the questioning and discussion procedure, the instruction was given explaining the corresponding concepts. The time spent on each unit varied from 10 minutes to 20 minutes, while students' participation in thinking and discussion took up about 30% of the teaching time overall.

The structure of the ITP may look similar to programs reported in the literature[15], but two major differences in this program need to be highlighted.

Firstly, the lecturer in the ITP always posed the concept questions before explaining the corresponding theory, ie, the sequence of *questioning before* *teaching*[16] was used. This is different from most of the research in interactive teaching in university physics, which is normally based on the conventional sequence of *teaching before questioning*[17]. The new teaching sequence aimed to create cognitive challenge for the students[18] considering their stronger physics background.

Secondly, the questions discussed in class were mostly context-rich. These questions provided familiar contexts, which were related to the students' everyday life, but were less explicit stated of the variables leading to the answers than the traditional problems, found in the back of the textbook chapters[19]. In other words, the context-rich questions are more challenging but are more meaningful for students' cognition. The literature in science education has highlighted the necessity of providing familiar contexts for students to construct a meaningful understanding of the concepts[20]. Resources of context-rich questions can be found in the literature of physics education[21].

Meanwhile, the ITP teaching drastically reduced the time spending on working through exercises, which is dominated by mathematical derivation[22]. This strategy can save valuable teaching time for students to think and discuss.

- ***Implementation of the ITP***

  The program was implemented at the commencement of the academic year to take advantage of the students' original positive learning attitudes. The ITP was taught by one of the authors (Chang) in one class. The program was implemented for only three weeks, 9 teaching hours.

- ***Evaluations of the learning outcomes***

  The learning outcomes of both the traditional teaching and the ITP were evaluated and compared in three ways. Firstly, 14 intervention students were interviewed during and after the implementation of the ITP regarding their perceptions of the interactive teaching design and comparing it with their experiences in high school physics. Secondly, immediately after the program, 53 intervention students and 327 students in seven traditional classes, taught by different lecturers, filled in a questionnaire evaluating the teaching design as well as their attitudes to learning. The questionnaire included both open-ended and closed questions. The closed questions used a five point Likert scale. Thirdly, the students' academic achievements were evaluated by a standardised test, called *Mechanics Baseline*[23], administered to the intervention class and two traditional classes before (pre-test) and after (post-test) the program.

To diminish the participating students' hesitations and encourage them to express their genuine perceptions of the program, the researcher gave two statements before conducting the survey and the interviews: (1) the purpose of this study was to investigate the strengths and weaknesses of the innovative teaching program and seek ways to improve current teaching, rather than to recruit positive comments to "prove" that the program is superior to the traditional ones, (2) the researcher will not be involved in their grading procedure.

Results

The outcomes of the ITP are discussed in three parts according to the evaluation tools used, which were (1) the intervention student interviews, (2) the student survey, and (3) the students' academic performance.

- ***Interview of the students in ITP***

  The intervention students mostly made positive comments about the program, which aimed to provide more opportunities and times to engage in learning. In this study, the interviews all adopted the interview guide approach format, ie, topics and issues to be covered were specified in advance, in outline form, and the interviewer was able to apply different sequences and wordings of questions to each interviewee. The student opinions are discussed according to two aspects: the strengths of the interactive teaching and the barriers, which impeded participation in class discussions.

  1. **Strengths of interactive teaching**

     The students commented that the perceived strengths of the interactive teaching approach were:

     (1) Cognitive processing

     All of the 14 students mentioned that the interactive teaching approach had promoted their engagement in thinking about physics concepts, which was very different from their learning experience in high school. For example:

> You are very different from my high school teacher because you always give us a couple of minutes to think about and discuss the concept questions. A better learning outcome cannot be obtained by letting the lecturer keep "dumping" something on us as our high school teacher did. We need time for thinking, not just for copying notes and memorizing formulas. (S1)

(2) Concentration and retention

Almost all of the students (13 of the 14) thought that the interactive teaching was beneficial to concentration and retention in class; for example:

> I have been hyperactive since childhood. This problem usually makes me feel uneasy sitting in class, and I have difficulty concentrating for more than ten minutes. But in your class, you allow us to participate in many different learning activities. This can help me a lot by drawing my attention to the lesson and making it easy to keep concentrating. (S7)

(3) Identification of misconceptions

Four of the 14 students said that the interactive teaching provided opportunities to challenge their understanding of the physics concepts and helped them identify their misconceptions; for example:

> Sometimes when I was explaining concepts to my partners, I can find that there are some mistakes in my prior understanding of the concepts. This is the advantage of (small group) discussion. (S3)

(4) Shifting focus from teaching to learning

Seven students commented that the ITP has shifted the focus of teaching from the teacher and teaching materials to the learners and learning outcomes. For example:

> Teaching should be like yours, which is more concerned about our learning (than your teaching), not just keep talking on your own. The focus of the class should be the students not the teacher. (S10)

(5) Teachers as learning facilitators

Nine students were asked, in the interviews, if they felt that the lecturer was lazy using the teaching time for students to work by themselves, and all of them gave an answer of "no", without hesitation; for example:

> S7: Your teaching always gives us time to think.
>
> Researcher: Have you ever thought that I am not committed to my teaching, because I don't keep teaching all the time (but give time for you to think and discuss)?
>
> S8: Not at all. It is good to let us discuss, not just about the answers, but also the reasons.
>
> S7: The time (for thinking and discussing) is worthwhile. Whether a teacher is committed to teaching or not depends on how much time s/he has spent on preparing and designing the teaching, not on keep talking in class. I believe that you have spent a lot of time preparing for your (intervention) teaching, because your teaching (style) is so different from other classes. The (focus of the) class (activity) should belong to the students not the teacher.

The ITP students' responses did not always agree with some other studies. For example, in Banerjee and Vidyapati's (1997)[24] study, they found that some students felt that they would not need the teacher anymore, since they felt they could learn by group discussion.

(6) Teach less and learn more

Most interviewees (12 of the 14) noted that the interactive teaching approach could be harmful to content coverage, but they also emphasized that the teaching is beneficial to them in enhancing their understanding of the concepts, and thus they learnt more from the interactive teaching approach. For example:

> Yes, you teach less with this kind of (interactive) teaching, because you have spent time to let us think and discuss;... but we understand more. (S11)
>
> I don't think this (interactive) activity is wasting teaching time and that the pace becomes too slow. Comprehension of some physics principles

> is more important than content coverage. (S6)
>
> On the surface, interactive teaching may make students feel that they have learnt less than through traditional teaching. The traditional way always keeps teaching, so it can teach more. But it is just a kind of "baby-feeding". The focus should be on how much we learnt, not how much the teacher taught. (S9)

Responses from the ITP students indicate that they are aware of the need to participate in the learning process in a physics class. The above statements agree with the findings of some researchers in university physics from western countries, who highlight the advantages of an interactive teaching approach in promoting learning engagement[25].

The above quotes show that while the intervention students expressed their appreciation of the interactive teaching approach, they also strongly criticized the traditional didactic teaching experienced in high school.

2. **Barriers to applying interactive teaching**

Although all interviewees pointed out many strengths of the interactive teaching, the students' participation in either whole class or small group discussion was not always high. Possible barriers of engaging students in discussion were also investigated in the interviews. The results are presented as follows.

(1) Insufficient physics background

Nine of the 14 students pointed out that their high school background in physics was weak, and this made it difficult for them to answer many questions, even those which looked simple. For example:

> The selection of the questions is very important. Just a little bit higher than what we know is fine; questions that are too difficult will undermine our confidence. (S3)
>
> The more we know, the more we will be involved in the discussion. If one had nothing in his mind, he will feel hesitant about discussing with others. (S10)

The students' concern with the level of the content is consistent with Meltzer and Manivannan's study (1996)[26].

(2) Being afraid of being blamed or teased by the lecturer or peers

Six of the 14 students said that they were afraid to expose their weakness in front of the lecturer and their classmates. They would rather leave the question unsolved than risk being put down by peers or lecturers. For example:

> Most of us dare not ask the lecturer questions. We are afraid that maybe the lecturer will blame us for asking such a simple question which had already been taught. Besides, we will worry that perhaps it is only us who has the question and that we will be teased by our classmates. (S4)

(3) Lecturers can not understand students' difficulties

Seven of the 14 students felt that the lecturer could hardly understand their difficulty. They felt that it is easier to communicate with their peers than with the lecturers. For example:

> Because lecturers have such a high level of academic achievement, they can hardly understand where we are at. (S4) Yes, indeed. (S1, S10)
> When I have questions, I would prefer to ask my classmates instead of the lecturer. Since lecturers have such a high academic achievement, they cannot really understand our difficulty. However, I dare to ask my friends every trivial detail because we learn it at the same time, and so they understand more about my problems. (S3)
> Yes, peers can use the words that we feel are easier to understand in order to explain our questions. (S1)

In summary, the students' perceptions of the possible obstacles to participate in discussion, including the difficulty of the questions, the relationships between peers, the classroom atmosphere, and the language barriers between the lecturers and the students, which have covered both cognitive and sociocultural aspects[27].

- ***The student survey: A comparison between the intervention and traditional teaching***

  The second part of the data is from the questionnaire survey. The results are presented under three headings: (1) students' perceptions of the teaching approach and affective learning outcomes, (2) students' comments about the main features of the course and their effects, (3) the crucial roll of interactive teaching in promoting intellectual engagement.

  (1) Students' perceptions of the teaching approach and affective learning outcomes

  The students' responses in the closed questions regarding their perceptions of the teaching approach and their affective learning outcomes are presented in Table I.

Table I: A comparison of students' responses between intervention (IT) (N=53) and traditional (TD) (N=327)teaching in closed questions

Questions	**agree %**		**t-test**
	IT	**TD**	
My physics lecturer has been aware of our learning outcomes when teaching	77	60	***
In the physics class, I am involved in the discussions	81	32	***
My physics lecturer has adopted a uni-directional delivery teaching method	4	27	***
The physics lessons promote my interest in learning physics	58	40	**
In the physics class, the teaching methods are monotonous	6	28	***
In the physics class, I feel that learning physics is a matter of enjoyment	55	47	*
I feel satisfied with the physics course overall	74	55	**
Until now, I have learnt nothing from this course#	0	8	**

*p<.05; **p<.01; ***p<.001

The students' responses in closed questions indicate a significantly divergent perception between the ITP and the traditional teaching. The ITP students responded with significantly more agreement that (1) the lecturer was more aware of the learning outcomes, (2) the students were involved in discussion in the class, and (3) the teaching was not uni-directional. The results show that the ITP successfully promoted interactions in class when compared with the traditional teaching approach. This finding may be surprising to many Taiwanese physics lecturers, who commonly perceive the task of engaging students in discussions as very difficult or even unfeasible considering the existing teaching environment[28].

The ITP students also expressed significantly more positive responses with respect to their affective learning outcomes when compared with their peers in traditional classes. These include: (1) interest in learning physics, (2) a lack of monotony in teaching methods, (3) feeling of enjoyment in learning physics, (4) feeling of satisfaction with the course overall, and (5) denial of learning nothing.

It should be noted here that the feeling of enjoyment appears to be less significant compared with other affective responses, such as feelings of interest, satisfaction, etc. This may be because the term "enjoyment" in Mandarin also implies "easy". As described above, the researchers intentionally increased the cognitive challenge for the students when designing the ITP. This strategy may therefore have reduced the students' feeling of "enjoyment".

(2) Students' comments about the main features of the course and their effects

In addition to the closed questions, the students' responses in the open-ended questions also indicated a considerable difference between the two styles of teaching. The open-ended questions asked the students to comment on the main features of the course, both the positive and the negative ones, and their effects. The ITP students gave more responses, about two to three statements per student, than the traditional group, who gave one statement on average. The major responses are listed in Table II.

Table II: A comparison of the students' comments about the features and their effects of the intervention and traditional teaching in the open-ended questions

	Intervention (53 students)	Traditional (327 students)
Interactive teaching approach	42%	4%
Introduces real life examples	49%	5%
Promotes interest (is boring)	25% (0)	2% (17%)
Stimulates thinking	24%	4%
Gives lucid lecture/teaching commitment	0	13%
Satisfaction with learning achievement	19%	1%

The data shows that the intervention students' perceptions were more positive than the traditional group's with respect to the teaching and learning in general. More than 40% of the ITP students commented on the interactive teaching approach and the introduction of real-life examples. On the contrary, no more than 5% of the traditional group of students commented on these two features. Examples of the ITP students' comments include:

> *Discussing with peers helps me realize my misconceptions rather than merely knowing the right concepts.*
>
> *The interaction between the lecturer and the students stimulates our thinking, and then promotes our learning interest.*
>
> *The course introduced many examples that we are familiar with in everyday life. This promoted my interest in learning physics.*

The above quotes indicate the ITP students' agreement with the interactive teaching approach and the introduction of real-life examples. These two features were also related to the outcomes of stimulating thinking and promoting interest. As a result, approximately a quarter of the ITP students commented that the teaching promoted learning interest and stimulated their thinking about physics concepts, while as low as 2-4% of the traditional students noted these two strengths. On the other hand, 17% of the traditional students expressed their feeling of boredom in physics classes in contrast to none in the intervention group. Examples of the traditional students' feelings of boredom are as follows:

> *Keeping copying notes throughout the whole lesson makes me feel really tired.*
>
> *The professor's tone was too flat, his classes lacked real-life examples and made it easy for me to fall asleep.*

The quotes indicate that the traditional students attributed the feeling of boredom in a physics class to the content design and the didactic teaching approach.
At the same time, the traditional students seemed to give much praise for the teaching performance and teaching commitments, while students' praise was absent in the ITP group. For example:

> *I like the professor's teaching performance. He can explain the concepts clearly and helps us to clarify the key points.*
>
> *I like the professor's attitude; he teaches conscientiously. However, I do not absorb the content well since I feel tired.*

The quotes indicate a paradoxical perception of the students: their appreciation of the teaching performance and commitment may exist along with disappointment in their own learning engagement and outcomes. Meanwhile, the quotes also indicate the traditional students' passive attitudes towards their learning, expecting the lecturers to clarify the key points and passively "absorb" the content. Although similar praise on teaching performance and commitment was absent in the ITP group, no students from the intervention class were found to criticize the lecturer for not giving lucid lectures and/or "working hard on talking". To the intervention students, these strengths seemed not to be an issue of concern. The program therefore seemed to successfully shift the students' focus from teaching performance to their own learning process and outcomes.

As a result, 19% of the intervention students expressed their satisfaction with the learning achievement in contrast to only 1% of the traditional group. Examples of the intervention students' comments are listed below:

> *I have a better understanding of the physics concepts. But a three-week period (for the intervention teaching) is too short. There is not enough time for us to comprehend a more flexible learning method. Also, we have not organized the concepts well yet.*
>
> *The teaching style helps me a lot in clarifying my understanding of the concepts, but some existing misconceptions are still hard to change.*

While the intervention students expressed their satisfaction with their learning achievement, some of them also indicated a broader perspective of their learning and their role as learners. The above quotes imply the intervention students' awareness of the complexity of learning physics as well as taking charge of an active role in the learning process. The program seemed to not only engage learning and promote affective learning outcomes but also develop the students' perspectives of learning.

The students' responses in the open-ended questions indicated their appreciation of the ITP design. A discussion of the links between the main features and their effects can help to further reveal the strengths of the new teaching approach.

- The crucial role of the interactive teaching in facilitating intellectual engagement. The two main features of the ITP, interactive teaching approach and introducing real-life examples, were found to link to the outcomes of stimulating thinking and/or discussion, promoting interest, and enhancing concepts, which are presented in Figure 2. The numbers are the students' responses, which made links between the features and the outcomes.

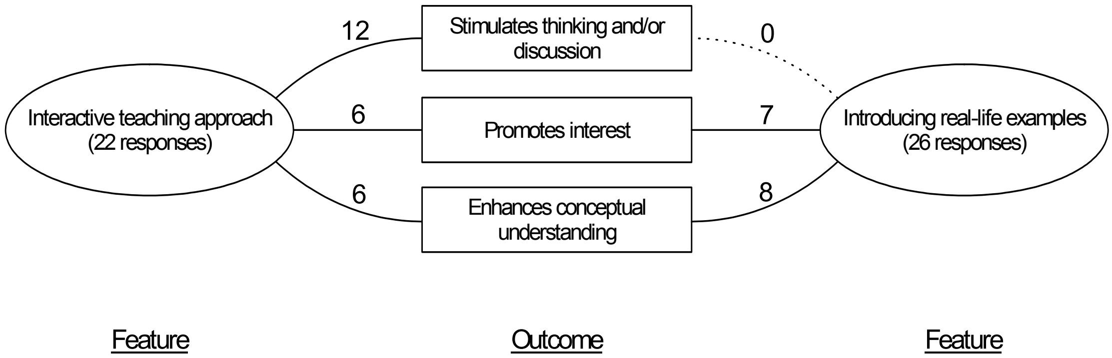

Figure 2 Two major features of the ITP and the number of students linking these to their outcomes.

Figure 2 shows that although both features of the ITP: interactive teaching approach and real-life examples, were noticeably linked to the outcomes of promoting interest and enhancing concepts, the outcome of stimulating thinking and/or discussion was shown to be related only to the feature of interactive teaching approach. The students made no direct link between real-life examples and stimulating thinking and/or discussion. The results imply that only introducing real-life examples may fail to engage the students' participation in the learning process. In other words, the modification of the traditional didactic teaching approach is essential for shifting the learners from being passive receptors to active participants in learning physics.

- ***The academic performance: A comparison between the intervention and traditional teaching***

  The third part of the data is the students' performance in a standardized test: Mechanics Baseline, and the results are listed in Table III.

Table III: A comparison between intervention and traditional teaching in Mechanics Baseline

Class average	pre-score[29]	post-score	Gain percentages[30]
ITP (N=57) [31]	47	50	6 %
Traditional A (N=53)	49	51	5 %
Traditional B (N=56)	53	57	8 %

The gain percentage results do not provide any evidence of the ITP teaching improving academic achievement. Regardless of the slight differences between the classes, the academic achievements overall are hardly satisfactory. The gain percentages are no more than 8%. To encourage the students' involvement in answering the test, the results of the post-test were counted as part of their grades[32]. Therefore, the poor results of the post-test should reflect their actual learning achievement and should be seen as a warning signal.

Possible reasons for the ITP teaching not producing any positive results in the academic test are discussed below.

Firstly, the tests included a wider scope of content than that covered by the ITP. The test covered the whole subject of linear mechanics, which had taken seven teaching weeks, while the ITP took only three of those seven weeks. Secondly, the test questions were presented in a traditional style, which is usually decontextualised when dealing with the physics concepts, while the questions discussed in the intervention program were embedded in the contexts of everyday life. The different context of the questions may have hindered the ITP students' performance in the tests[33]. Thirdly, the significant affective learning outcomes of the ITP may need more time to influence learning attitudes and learning strategies, and manifest themselves in the students' academic performance thereafter. With such a short intervention program, a significant improvement in academic performance is not expected.

Conclusion and Discussion

Based on the findings of this research, the outcomes of an interactive teaching approach compared with traditional teaching were found to be significant in three areas.

Firstly, the new teaching approach was found to successfully promote interaction and learning engagement, including concentration, thinking, and discussion. Secondly, the program developed the learners' perspectives of their own learning. The students in the intervention group seemed to shift their focus from teaching performance to their own learning when assessing the course. They became more aware of the learning barriers and took more responsibility for their own learning. This aspect of the outcome was mainly found from the open-ended questionnaire survey and the interviews. Thirdly, the results of the closed-question survey indicate that the ITP is beneficial to the affective learning outcomes, which included promoting interest, enjoyment, and satisfaction with the course. These results are consistent with similar studies in western countries[34].

Finally, however, there was no evidence to show that the intervention teaching achieved better performance in traditional tests. The academic achievement of the intervention group was found to be as "poor" as that of the traditional group.

This research also has implications in the following two areas:

Firstly, the findings from this study reveal the critical role of the interactive teaching approach in promoting learning engagement as well as broadening the students' perspectives of learning. These two learning outcomes are also emphasised by many other education researchers[35].

Secondly, in spite of many of the lecturers' hesitations about modifying the traditional lecturing under the restrictions of the existing teaching environment[36]*, this study showed that the implementation of an interactive teaching approach is feasible under the same teaching resources and students' situations. Although the intervention program was as short as three weeks, the outcomes were found to be promising, in developing students' metacognition as well as affective outcomes without sacrificing their academic performance in traditional assessment.*

In the context of an Asian country, this study has indicated the feasibility of promoting interaction within the existing teaching environment of university physics and the strengths of this new teaching approach, which expects to challenge the prevalent adoption of didactic lecturing by many physics lecturers. Based on this pilot study, an extension of the implementation of the ITP as well as modification of the traditional academic assessment tools are suggested. It is expected that a further research may help to reveal the strengths of the interactive teaching design as well as provide information for modifying the teaching design to better fit to the contexts.

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Gain percentage indicates what the students have obtained in relation to what they did not previously understand, as indicated by the pre-test. R. R. Hake, "Evaluating conceptual gains in mechanics: A six thousand student survey of test data," In E. F. Redish and J. S. Ridgen (eds.), The Changing Role of Physics Departments in Modern University (Proceedings of ICUPE. 689-698, American Institute of Physics, 1997).
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