

Applying Formative Assessment Techniques to Promote Students' Learning Outcomes and Interest

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Abstract—Assessment, especially classroom assessment techniques (CATs) is widely recognized as a vital component of teaching practice. To add one more proof to this confirmation, this study has been conducted to discover some impacts of practicing CATs in Physics teaching to Grade 11 students in Vietnam on their improvement of learning interest and outcomes. Some CATs were utilized to design assessment activities, and then put into practice. Observation and questionnaire survey were then conducted to collect data on students' responses during the instruction and by the end of instruction. A test to summative measure students' learning out-comes, having been administrated in two groups: with and without CATs practicing to evaluate the effective-ness of the CATs. The research results have shown that the assessment activities have actually facilitated students' interest and engagement in the lesson; in which students' learning outcomes are considerably promoted.

Keywords—*formative assessment; classroom assessment techniques; CATs; effects; impacts; learning outcomes; learning interest; students' interest*

I. INTRODUCTION

Recently, the education renovation of Vietnam has been so controversial, creating a big concern of the whole society towards education. It was mentioned in the general K-12 education program being announced by the Ministry of Education and Training in July 2017 that:

The purpose of assessment is to provide prompt and accurate, valuable information about the students' progress in learning and their learning achievements compared to the program's expected learning outcomes, utilizing assessment results to instruct students' learning, to revise instruction and education management, and to review curriculum development, ensuring the continuous improvement of students' learning and education in general [1].

The announcement has confirmed a change in recognition of the role of assessment in Vietnam education system: assessment is not only for the purposes of reporting students' achievement in learning and student classification but also for promoting their learning interest and facilitating their progress. This concept is absolutely in-line with a trend of innovation in student assessment worldwide: balancing the purposes of assessment: assessment must be for serving the formative purposes first, then summative ones.

Since 1960s and 1970s, purposes of assessment have been extended. Terms like formative assessment and summative assessment appeared with the meanings of providing feedback for teaching adjustment and reporting end-of-course learning outcomes respectively. To achieve these two purposes, scope of assessment has been gradually extended, covering students experience through learning courses, doing learning projects and presentation.

Many studies have been implemented, discovering and utilizing formative assessment in teaching. In Finland education system, assessment mostly serves the improvement of learning and teaching [2]. Most of assessment activities in classrooms are formative, in which students 'general competencies such as planning, analysis and synthesis, application, logical and critical thinking are paid more attention than others ever. In Australia, classroom assessment does not only focus on student achievement but also learning improvement and for awarding certification. Classroom assessment here is understood as assessment developed by instructors in their own classes. Singapore has recently been well known of her thinking class/school development and one of her innovative in this system is the facilitation of various classroom assessment techniques to assessment students' performance and products.

Imperial research in formative assessment has received a big concern, too, conducting in all levels of education [3-6]. All of these studies have shown the affectiveness or positive impacts of formative assessment on not only learning outcomes but also students' learning interest and engagement.

II. FORMATIVE ASSESSMENT

Formative assessment is defined as assessment implemented during the process of teaching with the purpose of improving learning and teaching. Formative assessment is conducted by both teacher and learner to provide feedback for learning and teaching adjustment, and for improvement of students' achievement in expected learning outcomes [7]. In formative assessment, teachers utilize different techniques and instruments, integrating them into teaching activities, making them as an internal component of teaching, helping students to practise and measure the achievement of expected learning outcomes [8]. Formative assessment is assessment happening during the instruction, this discriminate it from assessment conducted at the beginning of an instruction (placement

assessment) and that conducted by the end of an instruction (summative assessment).

Formative assessment and summative assessment often mentioned together as two activities in contrast in meaning, also defining two funder mental functions of assessment. Each one of them has their own attributes, regarding the purposes, methods and techniques for implementing.

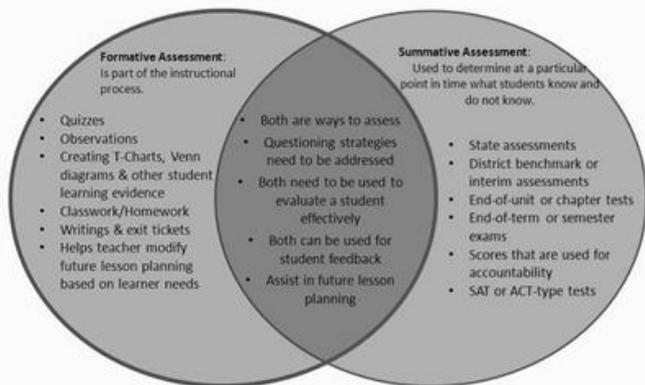


Fig. 1. A comparison of Formative and Summative Assessment [9].

Classroom assessment properly serves the function of formative assessment. Classroom assessment techniques (CATs) are frequent assessment strategies, which are often developed and implemented systematically to help teachers gather feedbacks on students' learning. Fortunately, teachers can be provided with feedbacks on students' learning right during the instruction to have relevant adjustment on their teaching. Many researches on the impacts of CATs and formative assessment have found out their positive influences on not only learning outcomes but also the increase of students' interest and engagement in learning.

To do this research, the following CATs had been chosen from Angelo and Cross [10]:

- CAT 1: Pop quiz for background checking
- CAT 2: Problem recognition
- CAT 3: Application card
- CAT 4: Attribute matrix
- CAT 5: Blank outline
- CAT 6: Memory matrix
- CAT 7: Wall drawing
- CAT 8: Feedback
- CAT 9: Constructive outline
- CAT 10: Pop quiz

These techniques are used through all phases of teaching process, from the beginning to the end of a lesson, not focussing on giving students with scores or student ranking but mostly for collecting feedback from the students, letting both the teacher and learners know where the learners are and how to get to the destination, helping the students improve their

learning. In the following sessions, some techniques, which have been developed and implemented in class will be presented and discussed.

III. ORGANIZATION OF PHYSICS TEACHING ACTIVITIES WITH THE APPLICATION OF CATS

The following procedure was applied to bring CATs into a Physics lesson teaching.

Activity 1 (10 minutes): Discover students' background knowledge and posing problems.

Activities of the teacher and students	Classroom assessment tools
<p>Game: "Together"</p> <p>Teacher: Talk about rules of the game: There are 12 multiple choice questions. Divide the class into 4 groups, each group will answer one question in turn. Each correct answer gets 10 points, wrong answers are not counted.</p> <p>Students: Join the game.</p> <p>Teacher: When you come to the last question, ask the correct answer group to explain your group's choice.</p> <p>Students: Explain their answer.</p> <p>Teacher: With the last question, we can not find the value of the appropriate angle of refraction. So why there is such absurdity, how this phenomenon is explained, we learn the lesson today.</p>	<p>Technique 2.1: Quick test</p> <p>QUESTION 1: In the following statements about reflection of the light, choose the correct one.</p> <p>1. The reflected ray is located in the second quadrant adjacent to the incident ray.</p> <p>2. The reflected ray lies in the plane of the incident and normal rays.</p> <p>3. When the incident ray is at the angle of incidence i, the angle of reflection is also i.</p> <p>4. The angle of reflection is always equal to the angle of incidence.</p> <p>QUESTION 2: The absolute refractive index of a medium is the ratio of the speed of light in vacuum to the speed of light in the medium.</p> <p>1. It is always greater than 1.</p> <p>2. It is always greater than 0.</p> <p>3. It is always equal to 1.</p> <p>4. It is always smaller than 1.</p> <p>QUESTION 3: When a light ray travels from air to water, the angle of refraction is 30°. The angle of incidence is 40°. The angle of refraction is 30°.</p> <p>1. $n_1 > n_2$ 2. $n_1 < n_2$</p> <p>3. $n_1 = n_2$ 4. $n_1 > n_2$</p> <p>QUESTION 4: A light ray travels from air to water, the angle of refraction is 30°. The angle of incidence is 40°.</p> <p>1. $n_1 > n_2$ 2. $n_1 < n_2$</p> <p>3. $n_1 = n_2$ 4. $n_1 > n_2$</p>

Source: Angelo and Cross (2013)

Fig. 2. The procedure of applying CATs in teaching.

12 assessment tools designed, using Angelo and Cross proposed by CAT, to teach two topics: "Light refraction" and "total internal reflection", can be seen in table 1.

TABLE I. CATS USING IN THE STUDY

CATS	Refraction of light	Total Internal Reflection
CAT 1: Pop quiz for background checking		
CAT 2: Problem recognition	X	
CAT 3: Application card	X	X
CAT 4: Attribute matrix		X
CAT 5: Blank outline		X
CAT 6: Memory matrix		
CAT 7: Wall drawing	X	X
CAT 8: Feedback	X	
CAT 9: Constructive outline		X
CAT 10: Pop quiz		X

A lesson plan was then developed, integrating the above CATs into different activities, employing teamwork, game playing, experiment implementing as a base for instruction. All these had been expected to create interesting and exciting lesson. Following are some specific activities having been planned and implemented in teaching the topic "Total Internal Reflection" – Physics Grade 11.



Fig. 3. Specific activities that have been planned and implemented in teaching.

When teaching without using assessment techniques, the opening activity is usually preceded by a math problem or by a phenomenon in life. Opening such articles is somewhat "dry" and "hard". With using Quick test technique through the emulation game between teams, answering the multiple choice questions can review the knowledge learned in the previous lesson, create excitement before a new lesson. This technique can be used at the beginning of the hour or at the end of the hour to assess students' ability to gain the knowledge.

Activity 2 (15 minutes): Find out the light transmission into rarer medium

Activities of the teacher and students	Classroom assessment tools												
<p>Teacher: To carry an experiment. Ask students to observe and complete the syllabus. Students: Complete empty outlines.</p> <p>Teacher: Check the empty outlines of a group's students. Summary: When i small \rightarrow 2 light beam: refracted and reflected beam, refracted beam far from normal and very bright, reflected beam is very faint \rightarrow Partial reflection phenomena. When i increasing \rightarrow reflected beam light up, refracted beam fades and toward the interface between the two media. When i rises to a limit, the refracted beam disappears, the reflected beam very brightly. \rightarrow Total internal reflection phenomenon. And the limited angle to no longer refraction is called the critical angle.</p> <p>Teacher: Analysis, comparison of the magnitude of the angle of incidence i and the angle of refraction r. Conclusions about the critical angle Students: Acquire knowledge.</p>	<p>Technique 2.3: Empty outlines Complete the empty outlines by matching the pieces with the appropriate content into the boxes.</p> <table border="1"> <thead> <tr> <th>Angle of incidence</th> <th>Refracted beam</th> <th>Reflected beam</th> </tr> </thead> <tbody> <tr> <td>$i < i_c$</td> <td></td> <td></td> </tr> <tr> <td>$i = i_c$</td> <td></td> <td></td> </tr> <tr> <td>$i > i_c$</td> <td></td> <td></td> </tr> </tbody> </table>	Angle of incidence	Refracted beam	Reflected beam	$i < i_c$			$i = i_c$			$i > i_c$		
Angle of incidence	Refracted beam	Reflected beam											
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Fig. 4. Activity 2 empty outline.

In the study of total internal reflection, after the students was observed experimentally and completed the blank outlines in Activity 2, students will easily generalize and summarize the concept of total internal reflection. Teacher is the person who summarizes and deepens the knowledge for students. Characteristic signs help students identify the prominent features of two phenomena's refraction and total internal reflection. Since, the students can distinguish cases that can occur phenomena.

IV. RESULTS AND DISCUSSION

The lesson plan was then experimented in two classes in a high school located in the city centre of Hanoi, one with CATS (called Group 1) and the other without CATs (called Group 2).

To check for the difference in Physics competency between the two groups, an analysis of students' previous semester summative score in Physics was conducted, with results as follows:

TABLE II. MEAN SCORES IN PHYSICS OF GROUP 1 AND 2

Statistics				
Group	Number of students	Mean	SD	SEM
1	43	7.6860	1.00038	.15265
2	40	7.4000	.82927	.13112

TABLE III. T-TEST ANALYSIS OF THE SCORE IN PHYSICS OF THE TWO GROUP

	Independent Sample Test						
	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	.327	.569	1.412	81	.162	.28605	.2053
Equal variances not assumed			1.422	79.973	.159	.28605	.20116

According to data from table 2, Group1's mean score is 7.68, higher than Group2's (7.4). However, T-Test results show the Sig. of F is 0.569 $>$ 0.05, means that the two groups' variances are not equal. And, the T-Test Sig. (2-tailed) $t = 0.159 >$ 0.05, indicating the difference of mean score of the two groups is not significant. This means the two groups though are different in Physics mean scores but we do not have enough evidence to prove that these two groups are different in Physics competency.

Class observation was then conducted with Group 1, where learning activities included some CATs. Students' performance was video recorded during the instruction. Besides, a survey questionnaire was then used to collect students' responses to CATs by the end of the lesson. These two activities got following results:

With Unit 27 "Total Internal Reflection", CAT 10- Pop quiz was used, on a base of teamwork playing a game. All students of the Group1 had chances to participate in the lesson, a competition among groups was created, as a result, students were eager and felt refreshed to start the lesson.

Class observation showed that students in all groups actively participated in the game, the classroom was very exciting. The survey results also shown more than 88% of students felt happy and enjoyed to warming-up activity. Only 2.3% of students was unsatisfied with it.

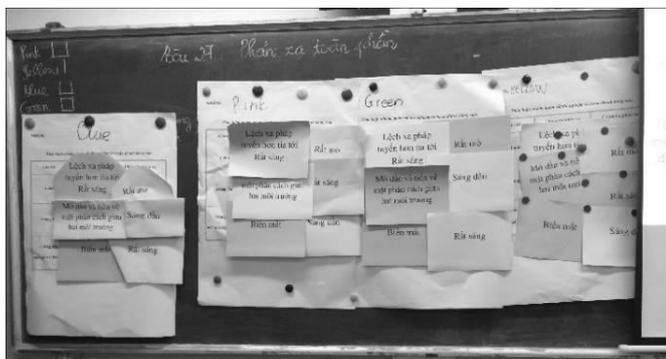


Fig. 5. Set of choice pieces for students to fill in the blank outline

To move the class to Activity 2 of instruction, students were provided with a Blank outlines and asked to fill the blanks with relevant piece of information that they had to choose from a given set of pieces. This helped students to acquire knowledge visually and the teacher could easily give feedbacks or adjust students' misunderstanding, right during the class.

Activity 3 (10 minutes): Find out the total internal reflection

Activities of the teacher and students	Classroom assessment tools															
<p>Questions: Through experiments, give a definition of total internal reflection.</p> <p>Students: Think and answer questions.</p> <p>Teacher: Comment on student's answer.</p> <p>Summary: Total internal reflection is the reflection of the entire incident ray, occurring at the interface between the two transparent media.</p> <p>Students: Ghi nhận kiến thức.</p> <p>Question: What is the difference between total internal reflection and refraction of light?</p> <p>Teacher: Respond to the defining features matrix and conclude.</p> <p>Students: Acquire knowledge.</p>	<p>Technique 2.4: Defining Features Matrix</p> <table border="1"> <thead> <tr> <th>Content</th> <th>Refraction of the light</th> <th>Total internal reflection</th> </tr> </thead> <tbody> <tr> <td>The light ray changes direction when it encounters the interface between the two media.</td> <td></td> <td></td> </tr> <tr> <td>A light travels from a media to denser medium.</td> <td></td> <td></td> </tr> <tr> <td>A light travels from a media to rarer medium.</td> <td></td> <td></td> </tr> <tr> <td>$i \geq i_{crit}$</td> <td></td> <td></td> </tr> </tbody> </table>	Content	Refraction of the light	Total internal reflection	The light ray changes direction when it encounters the interface between the two media.			A light travels from a media to denser medium.			A light travels from a media to rarer medium.			$i \geq i_{crit}$		
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Fig. 6. Activity 3 defining features Matrix.

The Activity 3 of instruction was implemented after the students had observed the phenomenon of total internal reflection and a definition of total internal reflection had been concluded by them. The use of attribute matrix then helped students to remember basic characteristics of the phenomenon. Moreover, students had a chance to compare it to another phenomenon – the refraction of light. With this CAT integrated teaching activity, 54% of students felt the learning interesting and very interesting, approximately 20% have no idea it and only 16% disliked.

Following is survey results in details – students' responses to assessment techniques they had experienced.

Figure 7 shows that most of students liked warming-up activities which are developed basing on natural phenomena. They were also interested in the application of knowledge right after the lesson finished. The fact that they were given chances to participate in some games or teamwork, doing science experiments, being listened by teachers and possessing equal

chances in expressing their opinion in learning, all these make them feel the lesson enjoyable.

Some specific teaching techniques like experiment observation, blank outline completion, student – teacher information exchange and sharing got positive feedback from almost every students in the group.

Among various teaching activities having been implemented, the activity in which students were asked to come to the board to complete the attribute matrix under a thorough supervision of the teacher received the least enjoyment from students. This may be explained that students want to perform in a really relaxed atmosphere.

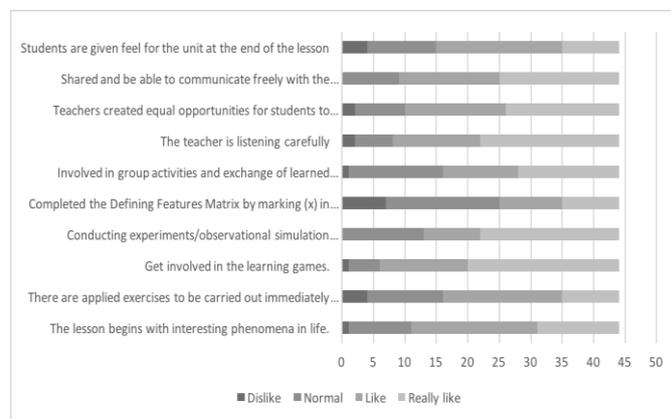


Fig. 7. Students' feedback on assessment techniques.

Figure 8 showed the level of students' agreement towards the items used to investigate students' affective responses to the teacher's implementation of CATs in the lesson. Most of the items received a strong agreement from the students. The data indicated an absolute satisfaction towards some arguments like: students had received detailed instruction for dealing with the task; they did not feel any pressure as participating the learning activities. It is reasonable to explain that the students' relaxed feeling is thanks to the teacher's guidance.

When CATs were integrated into teamwork learning activity, students were more concentrated into learning and as a result acquired knowledge more easily. Teamwork give students the chance to practise sharing and being responsible with the team's work. Teamwork also helped students to learn actively, to solve problems by themselves.

The figure 8 also gave an evidence that they really supported the lesson with CATs embedded. Most of them agreed that learning tasks included in the worksheets had relevant difficulty (57.8% chose agree and totally agree); Also approximately 58% disagreed that there had been too many learning tasks given to them during the lesson. The three Activities with CATs as mentioned had really made the Physics lesson lively and interesting (nearly 74% of chose agree and totally agree with this). Approximately 69% of students agreed that their knowledge of Physics had been acquired and consolidated in the class thanks to participating these learning activities.

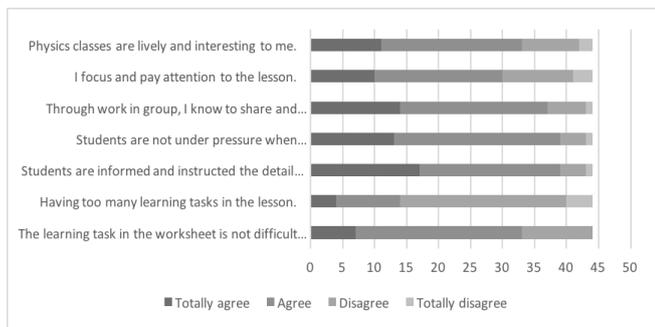


Fig. 8. Students' feedback on assessment techniques.

In summary, it is possible to conclude that if students are given chances to participate learning activity in the class, they will be responsible for their learning and active learn. The CATs has recruited students 'attention to the lesson, making them naturally focus on the lesson without coping any pressure. The Physics lesson had become really exciting and interesting.

To evaluate the effectiveness of CATs, a quick test had been conducted in both groups. Statistical analysis of the test scores showed that the mean score of Group1 is 7.44 while Group2 5.88. Score distribution is in table 4.

TABLE IV. THE DISTRIBUTION OF TEST SCORES OF GROUP 1 AND 2

Group	Score	3	4	5	6	7	8	9
1	Frequency			4	3	14	14	8
	%			9.3	7	32.6	32.6	18.6
2	Frequency	2	3	14	7	8	5	1
	%	4.7	7	32.6	16.3	18.6	11.6	2.3

Table 4 showed the distribution of the test scores administrated in Group 1 and 2. The Group1's scores range from 5 to 9, in which mostly distributed from 7 to 9 (83.8%), no one got scores lower than 5. Meanwhile, the Group2's test scores range from 3 to 9, in which mostly from 5 to 7 (67.5%); 5 students got scores lower than 5; the number of students got score 8 and 9 were really limited, accounting for only 14% of students.

Thus, with the assumption that the two groups were equal in Physics competency, the application of CATs in teaching did have impacts on learners' achievement in learning. The above analysis have confirmed this. To test whether existed a difference in learning outcomes between the two groups, T-Test analysis of mean scores was conducted.

Group1's test mean score is 7.44, higher than Group2's (5.87). Levene's test for equality of variances with Sig. is 0.140 > 0.05 indicated that the variances of test scores of the two groups were not equal. T-test for equality of means gave the Sig.(2-tailed) $t < 0.05$, led to a possible conclusion that the difference in mean scores between the two groups was significant. Group 1 had gained higher learning outcomes than Group 2.

To ensure the reliability of the statistical analysis of the survey and test data, Group1's test scores were analyzed to find out the level of students' achievement towards each learning

objectives, from that to evaluate to effectiveness of CATs implementation.

TABLE V. STUDENTS' ACHIEVEMENT OF LEARNING OBJECTIVES

Learning Objective	% Of Students with Correct Answer	CATS Having Been Utilized
1. State the laws of refraction and writes the equation of the law.	Item 5 (53.49%)	Pop quizz for background checking
2. State the concept of refractive index and absolute refractive index.	Item 1 (55.81%)	
3. Apply the equation of refractions law to define the refractive index, angel incident and angel of refraction.	Item 6 (97.67%)	Pop quizz
	Item 7 (100%)	
	Item 8 (74.42%)	
	Item 10 (86.05%)	
4. Describe the condition of total internal reflection	Item 2 (97.67%)	Blank outline
5. Differentiate the cases which happening refraction and total internal reflection.	Item 3 (11.63%)	Attribute matrix
6. Apply the formula of critical angel to identify cases which happening the total reflection of the light when crossing the interface.	Item 9 (81.39%)	Problem recognition
	Item 4 (86.05%)	
7. Apply the formula of critical angel to compute the critical angel and the quantities in the formula of critical angel.	Item 4 (86.05%)	Application card

Basing on data from table 5, it is possible to argue that the application of CATs in teaching has helped the students to achieve most of expected learning outcomes. Except for the learning objective No.5, where the assessment techniques of attribute matrix was employed in teaching, all the rest ones have been gained by more than half of students, some even by most of students. Further analysis of teaching activity for this objective need to be done thoroughly to find out the reason for this fact.

V. CONCLUSION

The research has shown that integrating CATs in teaching Physics lessons in high school is feasible and would bring about some benefits to students. The experiment of developing and conducting a Physics lesson to Grade 11 students, on the "Infraction of light" has revealed some evidences that students gained better learning outcomes and increased their learning interest. From the research results, is possible to conclude that: the use of CATs in teaching will make a lesson more exciting, facilitating students' learning interest; in CATs integrated teaching activities, students seem engage more in the lesson,

actively participate in learning: expressing their ideas, involving in their team's work and the class's discussion. Thanks to this, their communication and teamwork skills are surely improved; CATs as being designed and used relevantly to teaching contents and students will facilitate students' achievement of expected learning outcomes; CATs as being used frequently in teaching will help teachers to get and give frequent feedback from and to students. As a result, teachers recognize students learning gaps and their weaknesses and make timely remedial treatment to students. Also, students know where they are on the way to reach their learning objectives and have relevant adjustment to their learning; and in conclusion, classroom assessment techniques are quite beneficial to both learners and teachers. To make CATs promote students' learning interest and enhance their learning outcomes, they should be flexibly constructed and integrated into teaching activities with active learning pedagogy.

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