Jurnal Pendidikan 31 (2006) 143 - 156

Usage of Graphing Calculator Ti-83 Plus: Motivation and Achievement

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ABSTRAK

Dalam usaha ke arah pencapaian sebuah negara maju seperti yang termaktub dalam wawasan 2020, negara kita telah dan sedang mengalami banyak perubahan dalam proses pengajaran matematik. Aspek teknologi telah diintegrasikan dalam proses pengajaran dan pembelajaran. Tujuan kajian ini adalah untuk meninjau kesan penggunaan kalkulator grafik sebagai alat dalam mempertingkatkan pencapaian matematik. Kajian ini menggunakan reka bentuk kajian kuasi-eksperimen dengan memberikan ujian pra dan pasca bagi mementukan kesan penggunaan kalkulator grafik dalam proses pembelajaran. Subjek untuk kajian ini ialah pelajar tingkatan empat di kelas yang sedia ada supaya tidak mengganggu rutin harian sekolah. Dalam kajian ini subjek dibahagi kepada kumpulan eksperimen dan kumpulan kawalan. Pelajar dalam kumpulan eksperimen diajar meggunakan kalkulator grafik, manakala kumpulan kawalan hanya menggunakan latihan yang biasa. Kaedah kuantitatif dna kualitatif digunakan untuk mengumpul data. Bagi kaedah kuantitatif, ujian pra- dan pasca dalam pencapaian matematik, sikap terhadap matematik, dan soalan persepsi pelajar dalam menggunakan kalkulator grafik diberikan kepada subjek. Data kualitatif dipungut melalui pemerhatian dna temu duga. Keputusan kajian menunjukkan terdapat perbezaan yang signifikan dalam pencapaian matematik bagi kumpulan eksperimen berbanding kumpulan rawatan. Kebanyakan pelajar menunjukkan sikap yang positif terhadap penggunaan kalkulator dalam pembelajaran mereka.

ABSTRACT

As the goals of education begin to change to reflect new social and educational needs, teaching strategies also change, and so, consequently, do strategies for integrating technology into teaching and learning. The purpose of this study was to investigate the use of graphing calculator as a tool in enhancing learning of mathematics. In this study the researcher did not assign subjects randomly to the treatment. Instead, a total sample of subjects in two intact classes was used, that is, one experimental class and one control class from form four. The study employed a quasi-experimental with pretest-posttest research design to determine the treatment effects. The experimental group used graphing calculator-based worksheets and each student has access to one graphing

calculator during mathematics lesson. However, the control groups used textbook only and without graphing calculator. Both quantitative and qualitative methods were utilized to gather data. Quantitative data was collected using a pretest and posttest on mathematics achievement, mathematics attitude inventory, and questionnaire for students' perception. Qualitative data on the hand was collected by means of observation and interview. The results of this study showed that students in the experimental group showed significantly greater improvement on mathematics achievement than students in the control group. Most of the students showed positive reactions towards the use of graphing calculator in their learning.

INTRODUCTION

Malaysia, like many nations, is cognizant of the need to develop thinking students. In particular, there is a necessity to facilitate the education of smart learners capable of working competently and independently with others in teams in a technology-enabled environment who are motivated and aware of their own learning and performance. A recent question in the educational community is whether students will have a more meaningful learning experience by engaging themselves in a mathematics classroom. Positive climate is important because it creates an environment that encourages both achievement and motivation. Expectations for both performance and success are normally high. Students understand the requirements of learning tasks and perceive them as challenging, yet they feel safe from threats to their emotional security and self-esteem. They believe that the teacher is genuinely committed to their learning and is sensitive to their personal needs. Teachers with the help of technology like graphing calculator would be able to create a positive climate by encouraging students and allowing them to take intellectual risks without fear of criticism for making mistakes (Brophy 1990).

Our goal in promoting success is to create feeling of self-efficacy in learners, which means that the success must be on tasks learners perceive as substantial and worthwhile. Success on trivial tasks does little to create feelings of competence and self-efficacy.

A positive classroom environment creates a positive foundation for direct instruction to occur. Essential elements include a strong task orientation, usage of technology, positive expectations, and a success-oriented classroom climate. Within this positive learning environment, the teacher presents the instructional activities by encouraging students' involvement. However, the question now, "How do we know if we're teaching for understanding?" While this is a difficult question, we can offer some beginning guidelines for teacher questions and the monitoring of student answer in the classroom. First, questions such as:

"Why?"

"How do these compare?" ("How are they alike or different?")

"What would happen if?"

and particularly "How do you know?" can do much to promote student understanding. Surprisingly, teachers infrequently ask these questions as they interact with students in the classroom (Calfee 1986; Rosenshine 1987).

Students' answers that go beyond memorization provide evidence that understanding is developing. Questions and comments like the above and encouraging climate help students understand the reasons they are studying a particular topic. From social learning theory, we know that learners must expect to succeed and also believe that what they're learning is important and valuable if they are to be successful. To promote a sense of value, students must understand both what they're supposed to be learning and also why they're learning it. However, both of these are not present in the teaching and learning in our Malaysian classroom.

Success in today's competitive, diverse, and global business environment requires students to solve problems, collaborate with working teams, and use sophisticated technology to communicate. High quality learning occurs when:

1. The learner is ready (cognitively and emotionally), to meet the demands of the learning task
2. When the learner explicitly relates previous knowledge to the new
3. When the learner is active during learning
4. When the environment offers adequate support for the learner (Cairncross 2000).

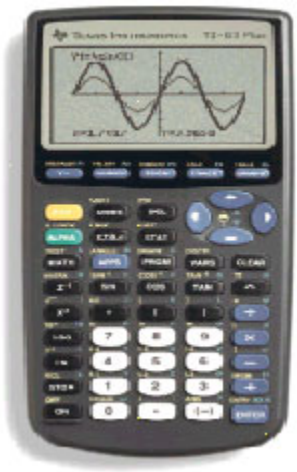
Graphing calculator is a relatively new technology that was developed as an aid in teaching and learning mathematics. As technology is now a major player in visualization and in the exploration of challenging concepts in Mathematics, this study aims to spearhead in using new technologies as tool in the teaching and learning of Mathematics and help creating a successful learning climate.

Students who are engaged in their work are energized by four goals – success, curiosity, originality, and satisfying relationships. But the question now, "How do we cultivate these drives in the students' lives? and What kind of work do students find totally engaging? Students want and need work that stimulates their curiosity and awakens their desire for deep understanding. As for topics that relate to students' lives, the connection here cannot be superficial; it must involve an issue or idea that is manageable. How can we connect them? To prepare students for life in today's highly technical society, their mathematical and science knowledge must include and go beyond knowledge in the simple skills into solving more complex problems. The Malaysian Smart School reform seeks to transform the traditionally directive univocal interaction environment to a more flexible multivocal interactive atmosphere between teacher-student,

student-student, and student-technology, where mathematical communications reexplicitly verbalized, and mathematical knowledge and understanding are thoughtfully explored. We need to prepare students who know how to identify problem and its solution, work in teams, communicate well, and know how to evaluate progress and learning.

THE TI-83 PLUS GRAPHING CALCULATOR

The TI-83 Plus graphing calculator is easy-to use and powerful hand-held tool that can be easily learnt by teachers, students, and those interested. All commands are placed in neatly arranged pull-down menus, and in the event that one cannot find the commands, the calculator's catalog gives an alphabetically arranged list of all the commands. The keys have also been strategically arranged in functional groups for easy access to the user, for example the arithmetic keys are together and so are the trigonometry keys.



TI-83 Plus can handle real and complex numbers, matrices and even strings. Its features for trigonometry, calculus, and simple algebra in the form of an equation solver will also meets the needs of most secondary school curriculum.

In addition, TI-83 Plus graphing calculator can carry out list-based one- and two-variable statistical analysis. The descriptive statistics and linear regression models are applicable to Malaysian secondary school curriculum, whilst the calculator's advanced hypothesis testing, confidence intervals and distributions.

The TI-83 Plus graphing calculator also has an added accessories that can further enhance its usability and practicality for classroom usage. For example, it has a calculator-to-calculator link cable that can transfer data from one calculator to another. This feature can be very useful for teachers wanting their classes to investigate the same set of data for purposes of teaching mathematical concepts. With a common set of data, teaching can be more focused and more effectively executed.

CONCEPTUAL FRAMEWORK

MOTIVATION IN THE CLASSROOM

Motivation is not just an initial energizing stimulus, but requires a continuous involvement by teachers and students over entire instructional programmes.

Students need to feel comfortable and accepted as learners in the classroom. By recognizing the diversity of the ability, cultures and values the teacher will be creating an environment which motivates, stimulates the natural enthusiasm, vitality, spontaneity and originality of students, as well as encourages an atmosphere of respect for self and others.

Student motivation naturally has to do with students' desire to participate in the learning process. Students who have an inherent desire to learn more about a particular mathematics topic, or who aim for personal satisfaction of solving a mathematical problem, are all intrinsically motivated. A student who is intrinsically motivated undertakes for its own sake for the enjoyment it provides, the learning it permits, or the feeling of accomplishment it evokes. On the other, students

Mathematical problem solving encompasses both applying mathematics to the solution of problems arising from the environment, and puzzling over and reasoning about questions that have arisen within a mathematical context. They need to be confident in applying the mathematics they have learned to situations in their environment and in interpreting their conclusions. Teachers can structure situations in which students investigate problems that are relevant to their daily lives and that help to answer the questions that students themselves are asking or can be encouraged to ask.

Encouraging them to reflect on and discuss the strategies they used and the knowledge and skills they required will assist in this process. These types of activities, which are good opportunities for group work, will also help them to gain the confidence to approach positively future mathematical learning and to be willing to apply the strategies they develop in familiar circumstances to unfamiliar situations and problems. Student motivation naturally has to do with students' desire to participate in the learning process (Noraini 2001). Students seek to find self-satisfaction in what they do in class, and they need external recognition or rewards for their achievements.

The following principles are concerned with procedures for motivating students to accomplish high levels of achievement:

1. Set realistic goals and reinforce students who make concerted attempts to achieve those goals. Students are motivated to learn if they perceive the instructional goals as realistic and relevant.
2. Students react positively to varied learning experiences based on games, demonstrations, project and used of technology.
3. Students are highly motivated by success and will normally strive to repeat school experiences that have led to worthwhile achievement in the past.

TECHNOLOGY AS A TOOL FOR INSTRUCTION AND LEARNING

Technology such as graphing calculator can be used to enable students to investigate and apply mathematical ideas in a way not easily achieved by other means. As we know that knowledge and ideas emerged only from a situation in which learners had to draw them out of experiences that had meaning and importance to them. These situations had to occur in a social context, such as a classroom. Technology also gives an opportunity for creating and exploring mathematical ideas where irrelevant details are eliminated. Graphing calculator has the ability to draw and analyze graphs, carry out complex computations, numerically solve equations, perform matrix arithmetic, statistical analysis and plotting a graph as in Figure 1 and 2.

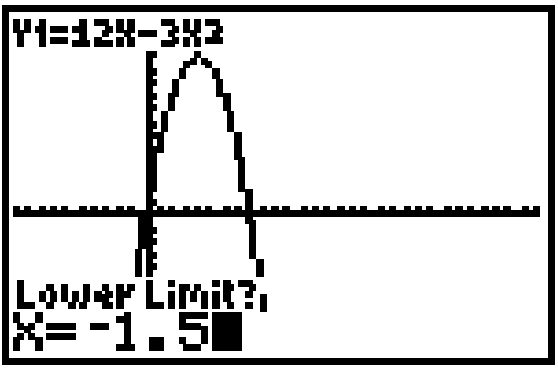


FIGURE 1: Plotting a Graph

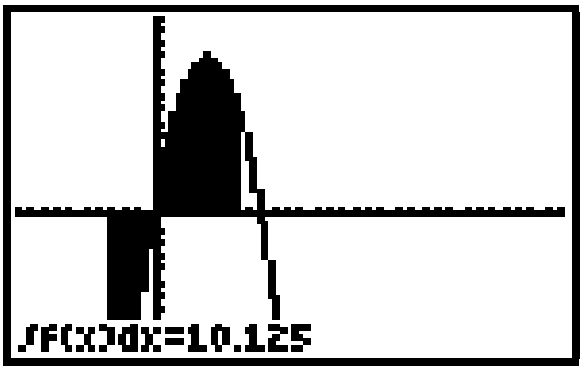


FIGURE 2: Area under the Graph

Technology can help students learn mathematics. For example, with calculators and computer students can examine more examples or representational forms than are drawn by hand, so they can make and explore

conjectures easily. The graphic power of technological tools affords access to visual models that are powerful but that many students are unable or unwilling to generate independently. The computational capacity of technological tools extends the range of problems accessible to students and also enables them to execute routine procedures quickly and accurately, thus allowing more time for conceptualizing and modeling.

Students motivation are enhanced when activity relates directly to students personal experience and when active participation in the lesson helps maintain it over time. Most students are activated by both intrinsic and extrinsic motivation. When solving problems students may be involved in creative process such as searching for alternative methods of solving a problem, creating and recognizing patterns, experimenting with different ways of communicating mathematical ideas, creating personal hypotheses, and generating problems.

The TI-83 graphic calculator have great potential as instructional aids for the development of mathematical/science concepts and understandings. It was developed as an aid in arousing curiosity. It has the ability to draw and analyze graphs, carry out complex computations, numerically solve equations, perform matrix arithmetic and statistical analysis (NCTM 1989).

The graphing calculator offers teachers and students a rich learning aid. Its potential is great and as yet untapped both in developing concepts and in developing positive attitudes and persistence in problem solving. As stated in NCTM's *Curriculum and Evaluation Standards for School Mathematics,* "the thoughtful and creative use of graphing calculator greatly improves the quality of the curriculum and the quality of children's learning" (1989, p.21).

PURPOSE OF THE STUDY

The purpose of this research was to investigate the use of TI-83 Plus graphing calculator as a tool in enhancing learning and how it helps in creating a climate for success. Specifically, this study focused on four main objectives:

1. To examine the effects of using graphing calculator on geometry achievement.
2. To examine the effects of using graphing calculator on students' attitude and motivation towards mathematics.
3. To describe the students' involvement in the process of learning in the classroom by using the calculator.
4. To discuss the perceptions of students towards the use of graphing calculator.

RESEARCH QUESTIONS

Four research questions were addressed in this study:

1. Students' attitude and motivation towards mathematics?
2. How does the students' involvement in the process of learning in the classroom by using calculator?
3. What are the perceptions of students towards the use of the graphing calculator to learn mathematics?

METHODOLOGY

Site. The study took place in one of the public secondary schools in Selangor. This school has 1205 students. This school serves a diverse academic, social, economic, and cultural population. The school's major goal is to enable all of its students to be successful in life by preparing them for higher learning.

Sample. The participants in this study were students (male and female) in form four. The average ages of the students were between 15 to 16 years. There were five classes in form four. According to the Principal each class was assigned with mixed ability – high, average, and low. After a discussion with the Principal and teachers, two intact classes were identified for this study. One class was assigned to be the experimental group (N= 55) and the other class was assigned to be the control group (N= 56). Both group had comparable socio-economic and ethnic backgrounds as well as comparable mathematics grades. The design for this study is represented below:

Experimental group	O1	X1	O2
Control group	O1	X2	O2

where O1 – pretest
X1- Treatment group using graphing calculator
2 - posttest

Instruments and Equipment. The instruments of this study consist of:

(1) Mathematics achievement test
In this study, the mathematics achievement test was designed to measure the students' knowledge in Statistics and Straight Lines and their ability to solve problems related to these two topics. It was a systematic formal test, using a paper-pencil procedure. Five experienced mathematics teachers with an average of 10 years of teaching experience were asked to validate the content.

(2) Mathematics Attitude Inventory
This questionnaire was adapted from Sandman's (1990) Mathematics Attitude inventory.

(3) Questionnaire for students' perception
This instrument was designed to evaluate the students' beliefs and perceptions towards the use of the TI-83 Plus graphing calculator in learning of mathematics.

(4) Interview Schedule
The equipment used in this study is TI-83 Plus Graphing Calculator.

Reliability and Validity of the Instrument. For testing the reliability of the instrument, Cronbach's Alpha method was used. The result of the reliability test for the mathematics achievement test (0.81) and mathematics attitude inventory (0.88). The contents of the instruments was validate by the panel of expert who have more than ten years o teaching experiences.

Procedure. For the experimental group, all students received the graphing calculator-based lesson. The main differences of these lessons as compared to traditional group was that they incorporated the use of the TI-8 Plus graphing calculator in helping the students visualize and conceptualize the mathematical concepts that were being taught. The lessons were also designed to encourage more interaction and communication among the students. Quantitative data was collected using a pretest and posttest Mathematics achievement, Mathematics Attitude Inventory, and questionnaire for students' perception. Qualitative data on the other hand was collected by means of interview. The researcher interviews six students. The interview sessions were audiotaped.

Data Analysis. Data from students' achievement in pretest and posttest, Mathematics Attitude Inventory, and questionnaire were analyzed using quantitative analysis. The SPSS was used to analyze the data. The analysis of the responses of the students were carried out based on the audiotaped interviews and the observation made by the researcher while conducting the interviews and the observation.

ANALYSIS OF DATA

STUDENT ACHIEVEMENT IN MATHEMATICS

To answer the question whether students in the experimental group using graphing calculator TI-83 achieve significantly greater improvement on Mathematics achievement compared to students in the control group who do not use the graphing calculator, the adjusted mean scores on the posttest of the two groups were determined. Table 1 provides a summary of the adjusted means of the experimental and control groups of subjects.

TABLE 1: Means and Standard Deviations for Experimental and Control Groups on Pre- and Posttest Mathematics

Test		Experimental	Control
Covariate (Pretest)	N	55	56
	Mean	11. 25	11. 30
	Standard Deviation	3.6	3.5
Dependent (Posstest)	N	55	56
	Mean	33.71	28.27
	Standard Deviation	3.2	3.1
	Adjusted Means	33.8	28.3

The pretest mean for the experimental group was 11.25(SD=3.6) compared to the control group means of 11.30 (SD=3.). The posttest means for both groups increased from the pretest, with experimental group showing the greater increase. Table 1 shows that the adjusted mean of the experimental group was significantly higher than the adjusted mean of the control group. The results showed that students in the experimental group showed significantly greater improvement on mathematics achievement than students in the control group.

STUDENTS SCORE IN MATHEMATICS ATTITUDE INVENTORY

To answer the question whether students in the experimental group using graphing calculator achieve significantly greater change in attitude and motivation score compared to students in the control group who do not use graphing calculator, the adjusted mean scores on the posttest of the two groups were determined. Table 2 provides a summary of the adjusted means of the experimental and control groups of subjects.

The pretest mean for the experimental group was 5.23(SD=3.88) compared to the control group means of 6.21 (SD=3.02). The posttest means for both

TABLE 2: Means and standard deviations for experimental and control groups on pre- and posttest

Test		Experimental	Control
Covariate (Pretest)	N	55	56
	Mean	5. 23	6. 21
	Standard Deviation	3.88	3.02
Dependent (Posstest)	N	55	56
	Mean	8.71	6.27
	Standard Deviation	3.76	3.86
	Adjusted Means	8.81	6.32

groups increased from the pretest, with experimental group showing the greater increase. Table 2 shows that the adjusted mean of the experimental group was significantly higher than the adjusted mean of the control group. The results showed that students in the experimental group showed significantly greater improvement on mathematics achievement than students in the control group.

STUDENTS INVOLVEMENT IN THE PROCESS OF LEARNING IN THE CLASSROOM

Attitude Toward Learning. Some students view and believe that learning using graphing calculator as opportunities to acquire new abilities and skills. Others consider learning using graphing calculator as presenting competitive situations in which their existing abilities and skills are challenged. During the interview, student P mentioned that,

" graphing calculator helps me to visualize the mathematical concepts clearly and be able to discover the mathematical task independently".

Problem solving, discovering relationships, proving theorems, analyzing situations, and interpreting mathematical communications are all cognitive tasks requiring students to work through perplexing moments. Those who are not confident in their own mathematical abilities tend to stop working on a task as soon as they become perplexed; more-confident students tolerate perplexity longer and are more likely to continue with the task.

In this study majority of the students are motivated to achieve learning goals that they consider relevant to their needs. For example, student Q said, "I really enjoyed learning mathematics now and looking forward to solve more problems". Students usually aim to achieve goals that they perceive as interesting. In this study, students in the experimental group were given similar opportunities. Students' insight opened up further possibilities for creative endeavour.

Communication Skills. Mathematics lessons typically require students to *receive* messages (e.g., by *listening* to the teacher and to one another and *reading* explanations, examples, and directions appearing in textbooks, on visual classroom displays, worksheets, computer screens, and tests). Schools typically provide students with extensive exposure to lessons targeting general communications skills (reading, writing, speaking, and listening). Most of the students in the experimental group agreed that "… efficient communicators present coherent and meaningful messages". In this study, it was found that the students were able to sequence messages in ways that allow students to interpret the intended meaning correctly. It was observed that with the help of graphing calculator, students in the experimental group emphasize important and relevant aspects of mathematics and also established positive relationship with each other and teacher. Teacher who focuses on efficient communication skills are better able to develop effective teaching styles.

Fifty three form four students in the experimental group completed a questionnaire to evaluate the students perceptions towards the use of the graphing calculator in learning mathematics was shown in Table 3. The scaled score is calculated based on 5 – strongly agree, 4 – agree, 3 – not sure, 2 – disagree, and 1 – strongly disagree.

TABLE 3: Students' survey result on the usage of graphing calculator

	Item	5	4	3	2	1
1.	It was easy to learn math using TI-83.	4	48	1	0	0
2.	I enjoy math better now than before.	10	41	1	1	0
3.	I like math better now.	12	38	2	1	0
4.	I learn math better with TI-83 instead of only with book.	11	41	1	1	0
5.	I spent more time on math now than before.	9	42	1	1	0
6.	I feel confident about trying a new problem on the TI-83	12	40	1	0	0
7.	Graphing calculator TI-83 help me in understanding the topics better.	11	41	1	0	0
8.	I am able to interact with my teacher and friends.	8	43	0	2	0
9.	It helps me to learn mathematics by discovery.	10	41	1	1	0

As shown in Table 3, most of the students showed positive reactions towards the use of graphic calculator TI-83. 10 students strongly agreed they enjoy mathematics better now than before, 12 students strongly agreed they feel confident about trying a new problem on the TI-83, 48 students agreed that graphic calculator help them to learn math, 41 enjoy math better now then before, 42 said they spent more time math now then before and 43 said that they more able to interact with teacher and friends.

CONCLUSION AND IMPLICATION

As a learning tool, graphing calculator can be seen as a catalyst for students' achievement. Several studies have attempted to compare overall achievement between experimental group for whom the graphing calculator is being used in instruction and control groups who were taught in traditional way. Quesada

and Maxwell (1994) and Smith and Shotsberger (1997) found significant different in the achievement between experimental group and control group.

To support classroom teaching and learning effectively, teachers must build a community in which students will feel free to express their ideas and create a climate for success. Student who obtain lower grades need help from teachers in order to share mathematical ideas with one another in way that are clear enough for other students to understand. In this study, learning to see things from other people's perspectives is a challenge for students. Students should gradually take more responsibility to participate in whole-class discussions and responding to one another directly. They should become better at listening, paraphrasing, questioning, and interpreting others' ideas. For example, students in the secondary schools are often reluctant to stand out in any way during group interactions.

Despite this fact, teachers can succeed in creating communication rich environments in mathematics classrooms by using graphing calculator as tool in his/her teaching. By the time students completed from secondary school, they should have internalized standards of dialogue and argument, so they always aim to present clear and complete arguments and work to clarify and complete them. Modeling and carefully posed question can help clarify age-appropriate expectations for student work. It is observed that in a positive climate students are treated as competent individuals capable of learning and understanding the need to learn.

Research on the use of graphing calculator in the mathematics classroom seems to indicate that, to date, calculators have positive effect on the learning of mathematics. The results of the study suggest that the use of graphing calculator in teaching and learning is beneficial in terms of students' level of understanding, communication skills, and achievement. The study also showed that the key to create a climate for success is involvement, which means that students are attending and are actively participating in the learning activity. With the use of graphing calculator, students are not only promoted to get involved but also to encourage students to participate in classroom discussion, to ask for explanations and justification for answers and thus creating a climate for success.

Students who have succeeded on a task, are able to connect mathematics and science to their lives are usually eager to do more of the same kind of task. They are motivated to achieve learning goals that they consider relevant to their needs (Noraini, 2001). Mathematics and science can be a creative activity involving intuition and intervention.

When students perceive learning to be interesting, fun, personally meaningful, and relevant and the context supports and encourages personal control, motivation to learn and self-regulation of the learning process occur naturally. Learning activities and experiences that students find interesting and stimulating are usually inherently motivating.

Among other things, students learn more and behave better when they understand and appreciate what is being conveyed. Students learning activities are influenced by teaching that either hinder or facilitate information processing in students.

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