

STUDENT LEARNING ASSESSMENT REPORT
FIRST SEMESTER 2006-07
DEPARTMENT OF PHYSICS - UPRM
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SECTION I: Mission and Student Learning Outcomes

MISSION

The mission of the Department of Physics derives from the triple mission of the University of Puerto Rico: Teaching: To educate our students to better understand and explore physical phenomena, to apply critical thinking in posing, analyzing and solving problems, and to maintain high professional standards in pursuing their careers. Research: To sustain and advance research and scholarship in Physics and related disciplines. Service: To promote Physics as a discipline throughout the university, the local school system and the community at large.

Student Learning Outcomes

The Physics Department Curriculum aims to develop graduates with the following skills and values:

- Critical thinking and problem solving skills through the scientific method
- A professional who values independent study and being self-taught
- Identification of the physical variables relevant to a physics problem
- Mathematical proficiency
- Identify stages and component areas in breaking-up physical problems
- Mathematical formulation of basic aspects of the contributing factors to a physical problem
- Basic laboratory skills for a methodical and fundamental investigation of physical phenomena
- Good communication skills in Spanish and English
- Computer skills for a systematic and fundamental investigation of physical phenomena
- Awareness of contemporary issues in physics
- Awareness of professional ethics
- Team working skills
- Develop an appreciation for the Arts and Humanities

The Physics Department Curriculum aims to develop graduates conceptually and quantitatively proficient in the following areas:

- CLASSICAL MECHANICS
- ELECTROMAGNETISM
- WAVE PHENOMENA AND OPTICS
- THERMODYNAMICS AND STATISTICAL MECHANICS

- QUANTUM MECHANICS
- ATOMIC PHYSICS
- SPECIAL RELATIVITY
- LABORATORY METHODS

Some graduates of the Physics program may also have additional competence in one or more of the following areas: Electronics, Nuclear and Particle Physics, Condensed Matter, Meteorology, Astronomy, Laser Physics, Applied Optics, Mathematical Physics, Computational Physics.

SECTION II: Student Learning Assessment

Physics 3171 is the first part of the General Physics sequence taken by engineering students. An equivalent course, PHYS 3161, is taken by physics majors. According to the UPRM Undergraduate Catalog description, 3171/3161 is a four credits course including mechanics, sound and thermodynamics (covered in that order). However, the course is so dense that most professors do not cover all the topics in the syllabus, claiming there is not enough time to do it. In particular, the thermodynamics part is the most affected since it is the last part of the course.

Last semester an intervention was done using Physics 4001 (Undergraduate Seminar I) to address deficiencies in thermodynamics of physics students. The course had an enrollment of three juniors and one senior. It was found that none of the students had discussed elementary thermodynamics concepts, like temperature and heat, in their introductory physics course. Those basic concepts are required in Physics 4057, Thermal Physics, which is a curriculum requisite in their senior year.

The undergraduate seminar usually entails preparing one or more talks in contemporary Physics issues. This time students were required to make several presentations in thermodynamics. The required level of the presentations was that of Halliday and Resnick, the actual textbook used in 3171/3161. A pre-test consisting of ten conceptual questions was given to students the first day of classes to assess their knowledge in the aforementioned area. Near the end of the course, the same test was repeated to evaluate the new knowledge. The pre/post test is included in Appendix A and a graph of the intervention results is shown in Figure 1 of Appendix B.

The same questionnaire used in the intervention described above was given to all students taking PHYS 3172 last semester. Those students were supposed to have taken 3171/3161 the previous semester, or earlier. A total of ten sections participated in the survey. The majority of participants were engineering students (90%), followed by physics (5%) and other science departments (5%). Most students failed the conceptual questions in the survey. However, due to the large number of students involved, it was not feasible to do an intervention to correct the situation.

Details of the intervention and survey, including results, are given in the next section.

SECTION III: Intervention Details, Results, and Recommendations

Sub-section	Content
Focus of Assessment Project	<ul style="list-style-type: none"> • The project objective was to measure the content knowledge in thermodynamics (TD) of students approving PHYS 3171 or its equivalent, PHYS 3161. Elementary TD concepts are supposed to be covered in the last 3 to 4 weeks of the course. They are needed for proper understanding of more advanced courses (like PHYS 4057). Thermodynamics is a key knowledge area in our list of student learning outcomes. • The assessment project had two components (a) an <i>intervention</i> for physics students and (b) a <i>survey</i> for engineering students.
Justification	<p>Several facts contributed to this assess project, among those:</p> <ul style="list-style-type: none"> • Complaints from professors that have taught PHYS 4057 (an intermediate course in TD, required for physics majors) about student’s poor background in heat concepts • Interview with professors teaching PHYS 3171-72 (Physics I and II) • Interview with students
Population	<ul style="list-style-type: none"> • The <i>intervention</i> involved four physics students, 3 juniors and 1 senior. It involved one professor. • A total of 169 students (90% from engineering) and 7 professors participated in the <i>survey</i> given in PHYS 3172.
Assessment Cycle	<p><i>Intervention for Physics juniors and seniors</i></p> <ul style="list-style-type: none"> • A pre-test consisting of ten conceptual questions in TD was given the first day of classes (see Appendix A). • The teaching strategy to improve student performance in TD included self study, individual discussions with professor, and oral presentations (seminars) of material by students. The physics Undergraduate Seminar (PHYS 4001) was used for this purpose. • The same test of ten conceptual questions was given the last day of classes. <p>=====</p> <p><i>Survey of students taking Physics II (PHYS 3172)</i></p> <ul style="list-style-type: none"> • A questionnaire having the same ten conceptual questions plus four additional general information questions (see Appendix B) was given in all sections of the service course PHYS 3172. The <i>survey</i> was administered from October 23 to November 3, 2006 to all students attending the ten sections of Physics II.

Results	<p><i>Intervention for Physics juniors and seniors</i></p> <ul style="list-style-type: none"> • In the intervention for physics majors, 3 out of 4 students answered correctly 40% or less of the pre-test questions. After the intervention 2 students answered correctly 7 or more out of 10 questions, while 2 answered correctly 5 out of 10 (see Appendix C, figure 1). <p><i>Survey of students taking Physics II (PHYS 3172)</i></p> <ul style="list-style-type: none"> • Only 13% of surveyed students were exposed to all TD topics in the PHYS 3171 syllabus. Almost 30% did not discuss TD. On the positive side, 70% got some TD coverage in their Physics I course (see Appendix C, figure 2). • Only 25 out of 168 answered correctly 50% or more of the conceptual questions (see Appendix C, figure 3). • Students whose professors discussed all TD topics in the 3171 syllabus answered correctly 20% or less of the questions. They obtained the lowest performance in the survey. In the other hand, students that were exposed to 1/3 of the topics obtained a score as high as 70% (see Appendix C, figure 4).
Dissemination of Results	<ul style="list-style-type: none"> • Leyderman Physics Seminar Series, January 18, 2007; 10:45 AM, F-436. • Arts and Sciences Assessment Committee Loop Closing Presentations, January 19, 2007; 9:45 AM, Eugene Francis, F-229.
Possible Reasons or Hypotheses	<ul style="list-style-type: none"> • There was some performance improvement for students participating in the <i>intervention</i>. However, they seem to have some serious TD misconceptions. These are hard to correct with the course format (seminars) used. Probably the traditional format of lectures (given by a professor, not the students), exams, and homework could yield a better performance improvement. • Regarding the <i>survey</i> among PHYS 3172 students, there are several factors contributing to the low performance. The main problem seems to be the lack of agreement in our department (at that time) regarding material extent and depth in the Physics I-II sequence.
Course of Action	<p>Several actions are under way to correct the situation. These include:</p> <ul style="list-style-type: none"> • A recent departmental agreement regarding what topics will be discussed in PHYS 3171-72 and their relative importance. • A recent departmental agreement to offer common final exams limited to a list of topics approved for the course. These will begin this semester. It is expected common partial

	<p>exams will follow next semester.</p> <ul style="list-style-type: none"> • A revision of the two/4 credits General Physics course for physics majors with the intention of replacing it by 3 courses of 3 credits each. The third of these courses would be Thermodynamics and Modern Physics.
Appendices	<p>A. Pre/Post Test Used In Intervention For Physics Majors B. Thermodynamics Survey For PHYS 3172 Students C. Intervention and Survey Results</p>

A. Pre/Post Test Used In Intervention For Physics Majors

NOMBRE _____

FECHA _____

I. Selecciona la mejor contestación.

1. La temperatura absoluta de un gas es una medida de
 - a. la energía cinética total de las moléculas
 - b. la energía potencial de las moléculas
 - c. la energía cinética de traslación de las moléculas
 - d. el tamaño de las moléculas
 - e. la energía total de las moléculas

2. La energía interna de un gas ideal depende de
 - a. la temperatura solamente
 - b. la presión solamente
 - c. el volumen solamente
 - d. la presión y la temperatura solamente
 - e. temperatura, presión y volumen

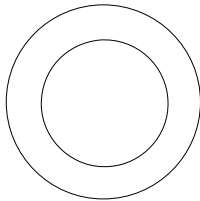
3. Un cuerpo C está en equilibrio térmico con un cuerpo A y otro cuerpo B. La ley cero de termodinámica dice
 - a. que C siempre estará en equilibrio térmico con A y B
 - b. que C debe transferir energía a ambos cuerpos A y B
 - c. que A y B están en equilibrio térmico
 - d. que A no puede estar en equilibrio térmico con B
 - e. nada sobre la relación de A y B

4. La ley cero de termodinámica nos permite definir
 - a. trabajo
 - b. presión
 - c. energía interna
 - d. calor
 - e. temperatura

5. Calor es
 - a. una propiedad que tienen los cuerpos debido a su temperatura
 - b. el contenido energético de un objeto
 - c. la energía transferida debido a una diferencia en temperatura
 - d. igual a una diferencia en temperatura
 - e. energía transferida usando trabajo macroscópico

6. Dos objetos de diferente material tienen igual masa y temperatura. Al añadirles calor, la temperatura final de cada uno puede ser diferente ya que tienen diferente
 - a. densidad
 - b. volumen
 - c. coeficiente de expansión
 - d. calor específico

- e. conductividad térmica
7. La formación de hielo a partir de agua envuelve
- a. una reducción en temperatura
 - b. la absorción de energía en forma de calor
 - c. una reducción en volumen
 - d. la liberación de energía en forma de calor
 - e. un aumento en temperatura
8. En un proceso adiabático de un gas ideal
- a. no hay intercambio de calor
 - b. la temperatura es constante
 - c. la presión es constante
 - d. hay intercambio de calor
 - e. el volumen es constante
9. De acuerdo a la segunda ley de termodinámica
- a. el trabajo no se puede convertir completamente en calor
 - b. el calor no se puede convertir completamente en trabajo
 - c. todos los motores de calor tienen el mismo rendimiento
 - d. es imposible transmitir calor de un foco frío a uno caliente
 - e. es imposible construir un motor de calor que sea 100% eficiente
10. Añadimos calor a un anillo de aluminio.
- a. el aluminio se expande hacia afuera, pero el hueco se queda igual
 - b. el hueco disminuye en diámetro
 - c. el área del hueco se expande en igual por ciento que cualquier área del aluminio
 - d. el área del hueco se expande en mayor proporción que cualquier área del aluminio
 - e. las fuerzas de expansión lineal hacen que el anillo adquiera forma un poco elíptica



B. Thermodynamics Survey For PHYS 3172 Students

NOMBRE _____

FECHA _____

I. Información general:

1. Soy estudiante de
 - a. física
 - b. ingeniería
 - c. otro departamento/facultad

2. Tomé FISI 3171 (3161)
 - a. el semestre pasado
 - b. hace 2 semestres
 - c. hace 3 semestres
 - d. hace más de 3 semestres

3. Mi nota en FISI 3171 (3161) fue
 - a. A
 - b. B
 - c. C
 - d. D

4. En el prontuario de FISI 3171 hay tres capítulos de termodinámica. Mi profesor cubrió más o menos
 - a. 1 capítulo
 - b. 2 capítulos
 - c. 3 capítulos, omitiendo algunos temas en el prontuario
 - d. 3 capítulos (todos los temas del prontuario)
 - e. no discutimos termodinámica

II. Selecciona la mejor contestación.

5. La temperatura absoluta de un gas es una medida de
 - a. la energía cinética total de las moléculas
 - b. la energía potencial de las moléculas
 - c. la energía cinética de traslación de las moléculas
 - d. el tamaño de las moléculas
 - e. la energía total de las moléculas

6. La energía interna de un gas ideal depende de
 - a. la temperatura solamente
 - b. la presión solamente
 - c. el volumen solamente
 - d. la presión y la temperatura solamente
 - e. temperatura, presión y volumen

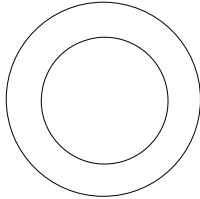
7. Un cuerpo C está en equilibrio térmico con un cuerpo A y otro cuerpo B. La ley cero de termodinámica dice
- que C siempre estará en equilibrio térmico con A y B
 - que C debe transferir energía a ambos cuerpos A y B
 - que A y B están en equilibrio térmico
 - que A no puede estar en equilibrio térmico con B
 - nada sobre la relación de A y B
8. La ley cero de termodinámica nos permite definir
- trabajo
 - presión
 - energía interna
 - calor
 - temperatura
9. Calor es
- una propiedad que tienen los cuerpos debido a su temperatura
 - el contenido energético de un objeto
 - la energía transferida debido a una diferencia en temperatura
 - igual a una diferencia en temperatura
 - energía transferida usando trabajo macroscópico
10. Dos objetos de diferente material tienen igual masa y temperatura. Al añadirles igual cantidad de calor, la temperatura final de cada uno puede ser diferente ya que tienen diferente
- densidad
 - volumen
 - coeficiente de expansión
 - calor específico
 - conductividad térmica
11. La formación de hielo a partir de agua envuelve
- una reducción en temperatura
 - la absorción de energía en forma de calor
 - una reducción en volumen
 - la liberación de energía en forma de calor
 - un aumento en temperatura
12. En un proceso adiabático de un gas ideal
- no hay intercambio de calor
 - la temperatura es constante
 - la presión es constante
 - hay intercambio de calor
 - el volumen es constante

13. De acuerdo a la segunda ley de termodinámica

- a. el calor no se puede convertir completamente en trabajo
- b. el trabajo no se puede convertir completamente en calor
- c. todos los motores de calor tienen el mismo rendimiento (eficiencia)
- d. es imposible transmitir calor de un foco frío a uno caliente
- e. es imposible construir un motor de calor que sea 100% eficiente

14. Añadimos calor a un anillo de aluminio.

- a. el aluminio se expande hacia afuera, pero el hueco se queda igual
- b. el hueco disminuye en diámetro
- c. el área del hueco se expande en igual por ciento que cualquier área del aluminio
- d. el área del hueco se expande en mayor proporción que cualquier área del aluminio
- e. las fuerzas de expansión lineal hacen que el anillo adquiera forma un poco elíptica



C. Intervention and Survey Results

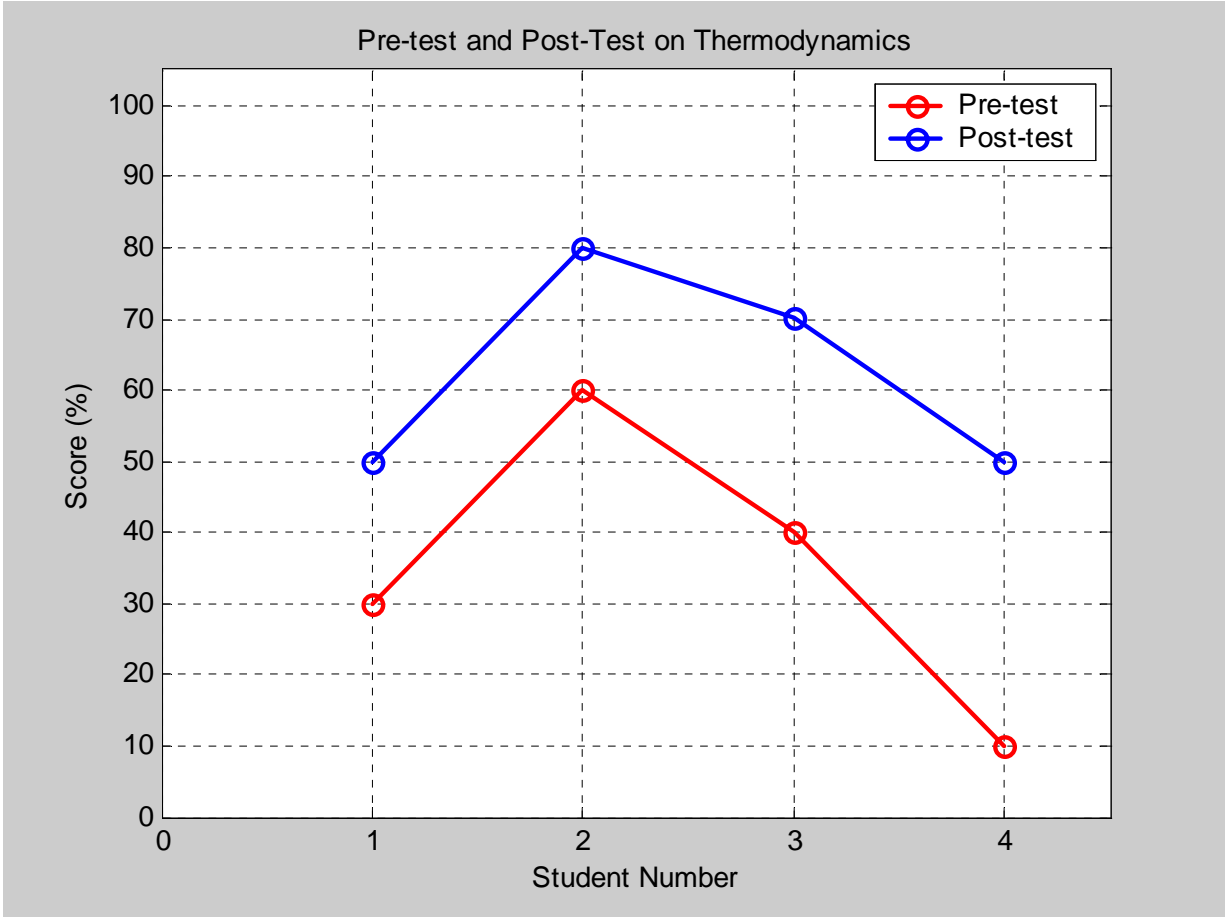


Figure 1. Pre-test and post-test performance of physics majors in intervention

4. En el prontuario de FISI 3171 hay tres capítulos de termodinámica. Mi profesor cubrió más o menos
- a. 1 capítulo
 - b. 2 capítulos
 - c. 3 capítulos, omitiendo algunos temas en el prontuario
 - d. 3 capítulos (todos los temas del prontuario)
 - e. no discutimos termodinámica

In the PHYS 3171 syllabus there are three chapters about thermodynamics. My professor discussed, more or less,

- a. 1 chapter
- b. 2 chapters
- c. 3 chapters, omitting certain topics
- d. 3 chapters (all topics in the syllabus)
- e. thermodynamics was not discussed

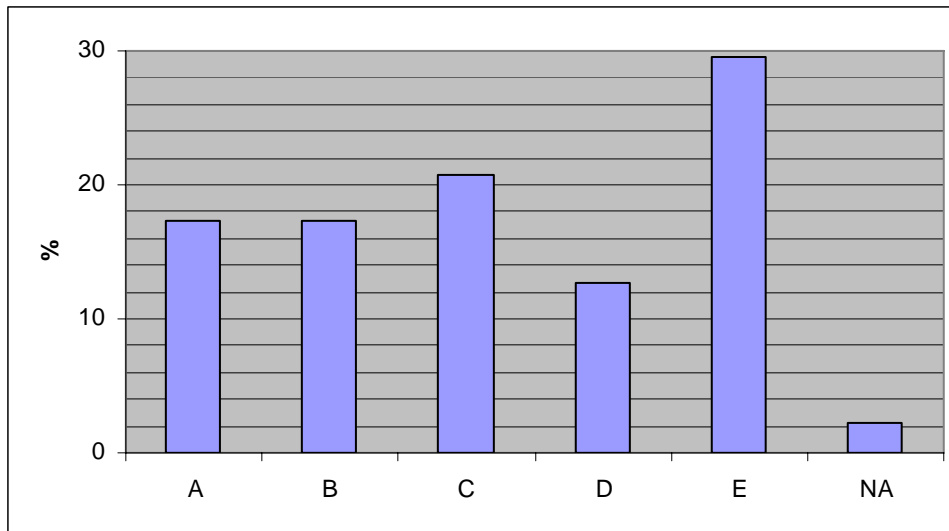


Figure 2. Thermodynamics coverage in PHYS 3171

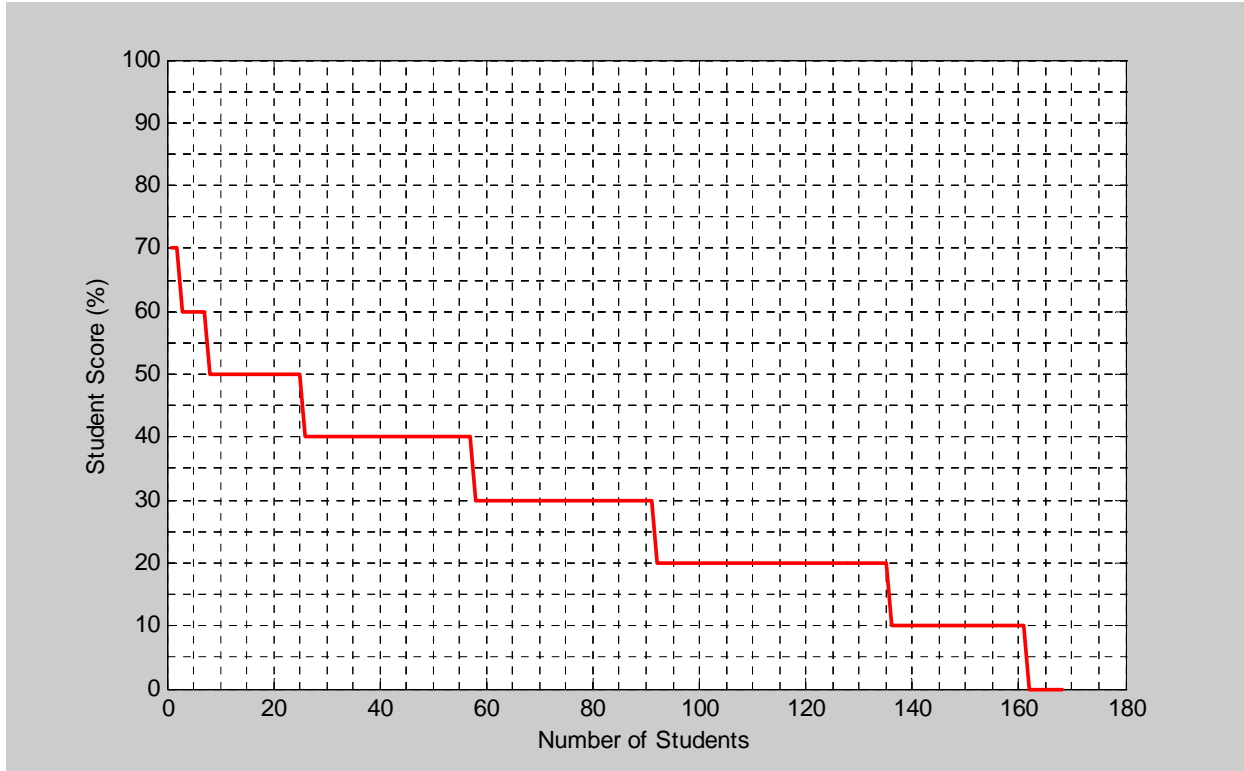


Figure 3. Performance of students in Thermodynamics survey

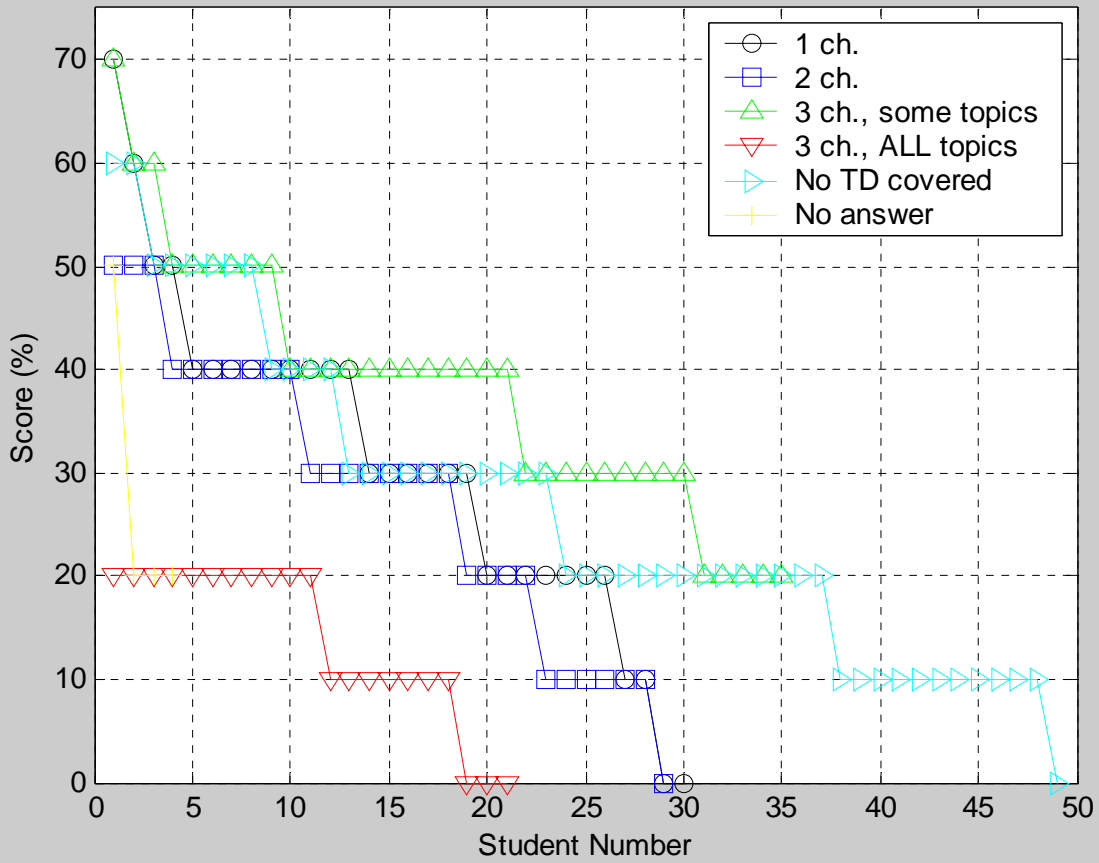


Figure 4. Student performance in Thermodynamics survey versus material covered