"ELEGANT" PROBLEM SOLVING MODEL FOR EFFECTIVE LEARNING AND APPLICATIONS

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Abstract - *Prologue: For the efficiency of an army (class) consists partly in the order and partly in the general (teacher); but chiefly in the latter, because he does not depend upon the order, but the order (of the class) depends upon him. All things… are ordered together in some way, but not in the same way; and the system is not such that there is no relation between one thing and another. There is a definite connexion [sic]. Everything is ordered together to one end the arrangement is like that in a household (class-hold), where the free persons (teachers) have the least liberty to act at random, and have all or most of their actions preordained for them, whereas the others (students) have little common responsibility and act for the most part at random. -- Aristotle, Metaphysics*

"Problem solving in general, whether it is used to solve mathematical problems at the school level, or in serious research that may lead to major (medical) breakthroughs, or simply to solve problems we encounter during our daily lives, is an indispensable skill that every well-educated person should acquire. There are some gifted people who have attained these skills in a natural way. Yet the vast majority of us require(s) some training to develop proper problem solving skills. Providing this training is perhaps one of the most important responsibilities resting with our educators. All too often students "pick up" problem solving skills through experience or as a bye product of doing exercises in mathematics or science classes. Watching the teacher or the textbook author plow through some problem situations can also lead to some lasting spin-offs." Herbert A. Hauptman, Nobel Laureate in Chemistry.

The objective of this paper is the development of a concept of problem solving in Industrial Technology majors from theory to practice. In studying Industrial Technology subjects, where the rigor is not on mathematics or deep concepts, but problem solution, students are exposed to some classical techniques of Industrial Engineering, Production and Operations Research, and Engineering Economics problems. Although some good students "all too often "pick up" problem solving skills through experience or as a bye product of doing exercises." It has been invariably seen that they never learn the problem solving strategies for efficient and elegant solutions. **Problem solving effectiveness is the direct result of Teaching and Learning Effectiveness.**

Introduction

This statement may seem to imply that effective teaching and learning will lead to effective problem solving abilities of the students. In fact, it does. There is no confusion in this statement that "**Problem solving effectiveness is the direct result of Teaching and Learning Effectiveness."** Effective teaching and learning could start from grasping the simplest problem for the child or may be even intended to train the "impaired adult student" to sort colored blocks into bins. In fact, colored blocks have been used in ergonomic studies to study the effectiveness of assembly line workers. Colored coded transistors with various combinations of color-coded stripes indicating good and bad transistors have been used in ergonomic research studies. In assembly set ups the color-coded transistors have bee used for the study muscle and eye coordination and productivity studies where the assembly line worker will be able to discriminate between the good and bad transistors by color code attributes under the various conditions of belt speed. The successful formulation of simplest problems is the hallmark of solving more complex problems for the child, adolescent and grown up students. Simplest problems are elaborated for effective teaching of complex problem solving. It also has something to do with appropriate methodology used for the individualized instruction developed for specific problem solving algorithms. Effective teaching and learning styles will provide an algorithm to grasp the bird's eye-view of a complex problem and apply it in the real world. This paper focuses on problem solving directly as an offshoot or "bye-product" of effective teaching and learning in general.

Although the title implies the development of an "elegant" problem-solving model the paper will discusses and explore the role of effective teaching and learning in general and in particular its effect on learning the art and science of problem-solving. Students' learning of the art of problem solving, and the application of this approach to the development and solution of a student-conceived project, contribute to the concrete "problem solving".

This paper discusses teaching and learning phenomena in the classroom. It has a prologue and a precept. It will also present an epilogue at the end of the paper, in conclusion, after having discussed some of the problem solving approaches and strategies for teaching effectiveness in

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the industrial technology classroom setting, where the higher-level engineering concepts must be translated to efficient and elegant solutions for applications. The student learning effectiveness will be analyzed from the firm evidence, that they learned the theory for the sake of practice.

"Elegant" and Applied Problem Solving Model

McDanield's introduction to curriculum design for problem solving best serves this introduction to this article. To quote him, McDanield [1] has observed that, " There seems little question that curriculum design must begin with a *concern* for the individuals who are most *concerned* with that curriculum: students and teachers…To the question, "What kind of learning materials will best prepare students for life in the year 2001?" he got the following which he neatly summarizes the content and intent of the curriculum.

- "Materials that will help maturing individuals cope *with their society.*
- Materials that will help maturing individuals *understand themselves.*
- Materials that will help maturing individuals *understand their investment in the future.*
- Materials that will help maturing individuals, *not to feel powerless and impotent.*
- Materials that will help maturing individuals *identify with the society they will inherit.*
- Materials that will help maturing individuals *understand the nature of change.*
- Materials that will help maturing individuals *see the means of affecting the direction of change.*
- Materials that will help maturing individuals *understand key social science concepts and their relation to change.*
- Materials that will help maturing individuals *identify roles they can take in the change process.*
- Materials that will help maturing individuals *incorporate classroom learning into their immediate environment.*
- Materials that will help maturing individuals *transfer classroom learning to future responsibilities.*
- Materials that will help maturing individuals *assist maturing individuals to create relevant learning situations.*
- Materials that will help maturing individuals *understand the role of maturing individuals in change.*
- Materials that will help maturing individuals *connect and become involved with maturing individuals.*
- Materials that will help maturing individuals *and maturing individuals change immature institutions.*"

Model's Applications to a classroom problem solving exercise

McDanield's model has helped us understand the curricular requirement and urgency of the learning to be applied to an industrial setting. A course entitled Production Management was selected for this purpose of analysis and the course was modeled such that at least three of the main criteria will be addressed for input and outcome of the course. The course was more outcomes driven that input driven. The topic that was selected for experimentation was use of forecasting, very naïve and very sophisticated models were used for student learning outcomes. The students worked for four weeks on developing a model for their use and appreciation starting from the naïve to the more advanced and scientific: moving average, weighted moving average, exponential smoothing, forecast including trend, linear regression and trend projection, regression and correlation studies, and finally time series analysis with classical seasonal decomposition. These problems were solved long hand by the students to appreciate and understand the science behind the topics and then finally they ran a computer solution using POM-software. The level of interest demonstrated by the students was conducive to this research. The use of software to generate a solution easily was optimized for the student to verify his or her homework and lab. But the project of collecting, formulating and solving an industrial problem was greatly facilitated by the application of the following course objectives of learning. Participation and appreciation level was very high because they felt, at the end of their involvement that:

- Course Materials did help them *understand their investment in the future.*
- Course Materials did help them *not to feel powerless.*
- Course Materials did help them *identify with the manufacturing society they will inherit, or work for.*
- Course Materials did help them *understand the nature of change in organizations.*
- Course Materials did help them *see the means of affecting the direction of change*
- Course Materials did help them *identify roles they can take in the change process.*
- Course Materials did help them *incorporate classroom learning into their immediate environment.*
- Course Materials did help them *transfer classroom learning to future responsibilities.*
- Course Materials did help them *assist other*

classmates following to the course, to create relevant learning situations.

More detail on how the model was applied to the day-to-day delivery of the operations management course would definitely be helpful to the reader and the gradual development of the model is presented below, as applied by students to their own problem setting.

A student in IT442: Production and Operations Management class was having difficulty in attending classes regularly due to various pleas: chronic depression, (wearing different hats in) different jobs, frequent interviews as a graduating senior, many hours of course load on top of that. Evidently she was an excellent student but was surely going to fail the course because of such distracting preoccupations. Can she learn to solve her individual problem by learning the concept and application of linear programming to see what is her optimal level of performance?

Can she apply the concept and take advantage of it for shaping up her life in the college and job? Yes, the course did help her define and solve her own problem as she has developed and applied the problem in her own life. The student's solved problem is appended at the end of the paper. The precept that "practical deliberation has its roots in the disposition of the student to act truly, rightly, wisely, with informed action which aims to educate and to deepen insight and to enliven commitment" has been tested hare. This proves the following important parameters of learning have been influenced.

- **Course Materials did help her *understand her investment in the future*.**
- **Course Materials did help her *not to feel powerless.***
- **Course Materials did help her *incorporate classroom learning into her immediate environment.***

The class did three Maximization Problems and Three Minimization problems. Many students had difficulty in formulating the problems with respect to resources and constraints in a verbally worded problem. When these problems were converted to their own problems at jobs they could easily visualize the problems and solve them as they had real interest in promoting themselves in their jobs. **This course Materials did help them *transfer classroom learning to future responsibilities.***

Model's Usefulness and Effectiveness

With respect to these above important contributions to the paradigms of inquiry, the "Elegant" Problem Solving Model is readily applicable to the usefulness and effectiveness of teaching. Rubinstein (1980) [2] suggests that, "Although the vehicles used to teach problem solving may vary slightly from instructor to instructor, all instructors include the following aspects in problem solving in general:

- Tools for problem representation
- Models as aids to thinking
- Identifying personal problem solving styles
- Learning to overcome conceptual blocks
- Dealing with uncertainty
- Focusing on the process of problem solving
- Decision making, individual and group
- The role of values in problem solving
- The holistic and interdisciplinary nature of human problem solving

In the line of "Patterns of Problem Solving" as enunciated by Rubinstein (1980) [2] the class made the following efforts to imitate the setup of a problem-solving classroom, which tries to offer an environment for the following human values:

- To develop a general foundation of problem solving approaches and master some specific techniques.
- To provide a foundation for attitudes and skills productive in dealing with problems in the context of human values.
- To emphasize the thinking process at all stages of the problem solving activity.
- To identify individual problem solving styles and learn to overcome conceptual blocks and self imposed constraints.
- To expose students to both objective and subjective aspects of problem solving.
- To provide a framework for a better appreciation of the role of tools and concepts that the students may have acquired or will acquire.
- To bring together students from diverse backgrounds so that they can observe different attitudes and problem solving styles and learn from each other.

Hence, teaching effectiveness in the classroom is essentially effective problem solving and decision making in the classroom. [3] According to Barnard (1978), the philosophy of effective teaching applied to classroom effectiveness for a timely problem-solving course is:

> "The fine art of effective decision making (teaching) consists in not deciding (teaching) *those* things that are not now ***pertinent***, not deciding (teaching a subject matter) ***prematurely***, not deciding (teaching) those things that cannot be made ***effective***, and not deciding (teaching) those things that ***others should make (teach)*.**"

Suggesting some guiding principles for the fine art of effective problem solving in the classroom, Rubinstein (1980) expresses the following sentiment of an effective mentor. [2]

- If you really want your students to learn a concept, give them an opportunity to teach you, the teacher.
- If a group of students is highly motivated and learns well, stay out of their way. Do not teach them; let them teach you.
- Concentrate on a small number of concepts, and dig deeply into their implications in as wide a field as possible.
- Make explicit the connection between knowledge and its application whenever possible.
- Show respect for the learners by preparing for each session.
- Encourage questions. Some questions are so outstanding that they should not be spoiled by an immediate answer; we should take time to ponder them. If this is the case, tell the students.
- Learn the names of your students. This is one of the best ways to motivate them and gain their respect.
- Do not tell a class: "We are behind." Your plan might have been unrealistic. Each class is unique; adapt your plans to the class and you will always be "on schedule," whatever it may be.
- When you explain something, seek feedback by asking: "Did I make myself clear?" This is better than: "Did you understand?"
- Do not express doubt about the learner's abilities to learn.

Concluding from the above experience of a seasoned teacher and scholar it can be concluded that learning effectiveness in the classroom is the management of human affairs continuously by a set of effective classroom behaviors of the teacher and the student alike which can be summarized like the following, succinctly paraphrased from to Barnard's (Acceptance) Theory of Authority and Effective Communication. Barnard (1978) [3]

Summarizing learning effectiveness as an art of managing (student) human affairs continuously in the classroom the governing precepts are:

- At the time of (concept/task) communication the "intellectual level and the language of teaching" must be perfectly understood by the student.
- At the time of (concept/task) communication it must be "accepted" as conducive/beneficial to the personal interest of the student.
- At the time of (concept/task) communication it must be "accepted" as conducive/beneficial to the class /organizational interest (stated goals of the course).
- At the time of communication the recipient must be psychologically and intellectually capable of executing the task (of learning). *A little impossibility here is a total possibility.*

Most Promising "Critical" Framework called "Praxis"

The interpretive framework is the most promising one. Carr and Kemmis [4] have given a good treatise to the subject of classroom effectiveness. The theory is based on tacit knowledge and values that guide individual's work. They state in support of this premise:

> Practical deliberation has its roots in the disposition of the actor to act truly, rightly, wisely and prudently -- the disposition called 'phronesis' by Aristotle It expresses itself in praxis -- informed action. ... Interpretive social science, historically, aims to serve such readers. It aims to educate: to deepen insight and to enliven commitment. Its work is the transformation of the consciousness, the differentiation of modes of awareness and the enlightenment of action. (Carr and Kemmis, 1986, p.93)

Authors like Argyris and Schon have extensively demonstrated the link of theory and practice for increasing professional effectiveness. Cervero has also written extensively on teaching effectiveness and continuing professional development of ET professionals engaged in teaching.

This framework is the most promising one, according to Carter (1983) [5]. For functioning in professional practice, Carter (1983) says that the effective teacher/practitioner must be an astute student of his/her work environment, which testifies to the theory practice two-way street. He also contends that academic preparation of practitioners should help the students in professional practice, which is theory embedded in practice. He also promises that systematic inquiry is the hallmark of successful practice, which testifies that medical theory or model of learning and practice are inseparable. Carr and Kemmis also agree with these important observations about educational and research practices.

> In these times … in education, the need for the profession to organize itself to support and protect its professional work is obvious. Moreover, if the central aim of education is the critical transmission, interpretation and development of the cultural traditions of our society, the need for a form of research which focuses its energies and resources on the policies, processes and practices by which this aim is pursued is obvious as well. Emancipatry action research, as a form of critical educational science, provides a means by which the teaching profession and educational research can be reformulated so as to

meet these ends. Car and Kemmis (1986) pp. 224. [4]

In conclusion, the theory-practice debate will continue to go on. Preference of the most applicable paradigm of problem solving in the classroom, as we step into the millennium, will depend on 'praxis', which may take a balance between the two ends, or a 'middle of the road situation' in applying theory to practice in the classroom.

This paper has now examined, the constructs and philosophical approaches of the schools of thought in problem solving in engineering and technology (E-T). It also tried to look into the major frameworks of constantly changing relationship between theory and practice. Critically examining these frameworks, an effort was made to see if any one of the frameworks has contributed most to the body of knowledge in E-T education, and which one holds the most promise for the future.

"No plan or scheme of education will be complete, if it did not take into account the moral faculty as well as the intellectual faculty," in a challenging classroom. (Richard Owen, first president of Purdue University). What happens in the classroom is a direct result of Discovery, Learning and Engagement of a student in the art of the classroom teacher. (Martin Jischke, present President of Purdue University).

Before closing, although this paper seems to be primarily a collection of quotes from the literature on problem solving that are only tenuously connected they cannot be looked upon as adding nothing to the literature of problem-solving in engineering and engineering technology. Actual problem solving in engineering classroom has been tried and appended at the bottom showing how the students in question developed intuitive familiarity in "framing" and developing their application problems to benefit themselves in their scholarship and lives.

The author is grateful to the reviewers who suggested that the scope of this paper may be further enhanced if authors like Woods, Fogler and Leblanc, and many others' work could be incorporated into this study. These authors have written in the past three decades on helping students acquire problem-solving skills. Consequently the author will try to incorporate those innovations that they have added to the field of problem solving. After completing the research on this the author will try these concepts in his classroom.

Epilogue

"Anyone who sees all this, naturally rushes to the conclusion of which I was speaking, that no mortal legislates in anything, but that in (student) human affairs chance is almost everything. And this may be said of the arts of the sailor, and the pilot, and the physician, and the general ***(teacher)*,** and may seem to be well said; yet there is another thing, which may be said with equal truth of all of them.

What is it? That God governs all things, and that chance and opportunity cooperate with Him in the government of human affairs.

There is, however, a third and less extreme view, that art should be there also; for I should say that in a storm there must surely be a great advantage in having the aid of the (teacher's) pilot's art.

You will agree?" -- Plato, *Laws*

Reference

[1] McDanield, M. A. (1974). Tomorrow's curriculum today. In Alvin Toffler (Ed.) *Learning for Tomorrow: the role of the future in education*, Vintage Books.

[2] Rubistein, M. F. (1980). *A decade of experience in teaching an interdisciplinary problem solving course.* In Tuma and Reif (Eds.) Problem solving in education: Issues in teaching and research. Lawrence, Erlbaum Associates publishers

[3] Barnard, C. I. (1978). Functions of the executive. MIT press. Revised edition.

[4] Carr, W., and Kemmis, S. (1986). *Becoming critical: Education, Knowledge and Action Research.* London: Falmer. (chapters. 2,3,& 5)

[5] Carter, G. (1983). *A perspective on preparing adult educators*. In S.M. Grabowski (Ed.) Strengthening connection between education and performance, New directions for continuing education (pp.73-82), Jossey-Bass

Appendix A (below): A student project as envisioned and solved by the student after learning optimization.

Maximization Problem defined: XYZ is graduate student and a consultant who repairs computers and also designs web pages to put herself through graduate school. She must utilize her weekly working hours efficiently to achieve optimal performance, and must complete all work by their firm deadlines. She cannot work more than 40 hours per week and can afford only 10 hours of daytime work a week due to school requirement. Please see table below for constraints.

Minimization Problem defined: XYZ is a full time graduate student and a teaching assistant. She must utilize her weekly working hours efficiently to achieve optimal performance, and must complete all work by their firm deadlines. She cannot work more than 40 hours per week and is enrolled in 12 hours of class, which should be further allotted two hours for every hour in class. The costs are $8/hr as the cost for her job and $53/hr for 36 hours of schoolwork (Tuition = $1936/36 hours). She must sleep at least 8 hours every night, all week to be at a healthy working condition (56 hours). She can only work execution hours M-F 7:30 am – 5:30 pm (10 hours a day). Please see table below for constraints.

IT 442

Student XYZ

Linear Programming Maximization Problem

Problem defined: Student XYZ is a consultant who repairs computers and also designs web pages to put herself through school. She must utilize her weekly working hours efficiently to achieve optimal performance and work completion.

She cannot work more than 40 hours per week and can afford only 10 hours of daytime work a week due to school requirements.

The following is a table showing the hours currently used in each work situation.

Nature of work	Web Pages	Computer Repair	Available Hours /Week
	Hours required to produce one unit/repair		
Preparation	10	2.5	30
Execution	2	5	10
Profit per Hour	$15	$8	

How many units/repairs a week must be devoted on Web Pages and Fixing Computers to maximize income?

Final Max Probl. IT 442 Student XYZ

Hours required to produce one unit/repair

Nature of Work	Web Pages	Computer Repair	Available Hours per week
Preparation	10	2.5	30
Execution	2	5	10
Profit per Hour	$15	$8	

Objective function: $15X_1 + 8X_2$ = Maximize Profit

First Constraint: $10X_1 + 2.5X_2 \leq 30$

Second Constraint: $2X_1 + 5X_2 \leq 10$

X_1 = Web Pages
X_2 = Computer Repair

LP Standard Form

Maximize Profit: $z = 15X_1 + 8X_2$

or: $z - 15X_1 - 8X_2 = 0$

$10X_1 + 2.5X_2 + S_1 = 30$

$2X_1 + 5X_2 + S_2 = 10$

$X_1 \geq 0,\ X_2 \geq 0,\ S_1 \geq 0,\ S_2 \geq 0$

First Simplex Tableau

Basic	z	X_1	X_2	S_1	S_2	Soln.	Ratio
z	1	-15	-8	0	0	0	
S_1	0	10	2.5	1	0	30	30/10 = 3
S_2	0	2	5	0	1	10	10/2 = 5

Entering = X_1 ; Leaving = S_1 Pivot Element

Type 1 + 2 Actions

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	-15	-8	0	0	0
	0	15	3.75	1.5	0	45
new z	1	0	-4.25	1.5	0	45
X_1	0	1	0.25	0.1	0	3
S_2	0	2	5	0	1	10
	0	-2	-0.5	-0.2	0	-6
new S_2	0	0	4.5	-0.2	1	4

New Simplex Tableau

Basic	z	X_1	X_2	S_1	S_2	Soln.	Ratios
z	1	0	-4.25	1.5	0	45	
X_1	0	1	0.25	0.1	0	3	3/.25 = 12
S_2	0	0	4.5	-0.2	1	4	4/4.5 = .888

Entering = X_2 ; Leaving = S_2 Pivot Element

Continued →

Type 1 + 2 Actions

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	0	-4.25	1.5	0	45
	0	0	4.25	-0.187	0.935	3.774
new z	1	0	0	1.313	0.935	48.774
X_1	0	1	0.25	0.1	0	3
	0	0	-0.25	0.011	-0.055	-0.222
new X_1	0	1	0	0.1111	-0.055	2.778
X_2	0	0	1	-0.044	0.22	0.888

Final Tableau

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	0	0	1.3113	0.935	48.774
X_1	0	1	0	0.1111	-0.055	2.778
X_2	0	0	1	-0.044	0.22	0.888

$Z = 48.77 \quad X_1 = 2.778 \quad X_2 = 0.888$

IT 442

Student XYZ

Linear Programming Minimization Problem

Problem defined: Student XYZ is a teaching assistant for an undergraduate class and a full time student at Purdue University. She must utilize her weekly working hours efficiently to achieve optimal performance and work completion.

She cannot work more than 40 hours per week and is enrolled in 12 hours of class (which should be further allotted 2 hours for every hour in class).

The costs are $8/ hour for as the cost for her job and $53/hour for 36 hours of schoolwork (Tuition=$1936/36 hours).

She must sleep 8 hours a night, every night, all week to be at a healthy working condition (56 hours).

There are 168 hours in a week.

She can only work execution hours M-F 7:30am-5:30pm (10 hours a day).

The following is a table showing the hours currently used.

"Product"	School	TA	Available Hours /Week
	Hours required to produce one unit		
Preparation	24	3	62
Execution	12	10	50
Cost	$53	$8	

How many hours a week must be devoted on School and TA work to minimize cost?

Final Min Problem IT 442 Student XYZ

Hours required to produce one unit

"Product"	School	TA	Available hours per week
Preparation	24	3	62
Execution	12	10	50
Cost	$53	$8	

Objective function: $Z = 53X_1 + 8X_2$

$24X_1 + 3X_2 \geq 62$

$12X_1 + 10X_2 \geq 50$

X_1 = School
X_2 = TA

LP Standard Form

Minimize Cost: $Z = 53X_1 + 8X_2$

or: $Z - 53X_1 - 8X_2 = 0$

$-24X_1 - 3X_2 + S_1 = -62$

$-12X_1 - 10X_2 + S_2 = -50$

$X_1 \geq 0,\ X_2 \geq 0,\ S_1 \geq 0,\ S_2 \geq 0$

First Simplex Tableau

Basic	z	X_1	X_2	S_1	S_2	Soln
z	1	-53	-8	0	0	0
S_1	0	-24	-3	1	0	-62
S_2	0	-12	-10	0	1	-50

Ratios $X_1 = \frac{-53}{-24} = 2.208$

$X_2 = \frac{-8}{3} = 2.661$

Entering = X_1 ; Leaving = S_1 ; Pivot Element

Type 1 + 2 Actions

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	-53	-8	0	0	0
	0	53	63/8	-53/24	0	136.91
new z	1	0	-1.375	-2.208	0	136.91
X_1	0	1	1/8	-1/24	0	31/12
S_2	0	-12	-10	0	1	-50
	0	12	12/8	-12/24	0	31
new S_2	0	0	-8.5	-1/2	1	-19

New Tableau

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	0	-1.375	-2.208	0	136.91
X_1	0	1	1/8	-1/24	0	2.583
S_2	0	0	-8.5	-1/2	1	-19

Entering = X_2 ; Leaving = S_2 — Pivot Element

Continued →

Type 1 + 2 Actions

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	0	-1.375	-2.208	0	136.91
	0	0	1.375	0.0797	-0.160	3.073
new z	1	0	0	-2.128	-0.160	139.98
X_1	0	1	1/8	-1/64	0	2.583
	0	0	-1/8	-0.0072	0.0146	-0.279
new X_1	0	1	0	-0.048	0.0146	2.304
X_2	0	0	1	0.058	-0.117	2.235

Final Tableau

Basic	z	X_1	X_2	S_1	S_2	Soln.
z	1	0	0	-2.128	-0.160	139.98
X_1	0	1	0	-0.048	0.0146	2.304
X_2	0	0	1	0.058	-0.117	2.235

$Z = 139.98 \quad X_1 = 2.304 \quad X_2 = 2.235$