Can System Dynamics Improve Project Management Teaching？ An Experimental Study

by

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Teaching fishing is better than giving fish.

---- Confucius（551-479 B.C.）

Abstract

With the great economic development, more and more well trained project mangers are demanded. Unfortunately, evidence show traditional project management training fails to provide prospective project managers with the conceptual insight or planning tools for making decisions in ways that minimize undesirable unintended consequences. The process of project management can be conceptualized as a complex information feedback system. System dynamics modeling to analyze and support project management decision-making is a long research tradition. It was used as the based model tool for simulator in project management education recently. But in that study, simulator was emphasized in education and students were not trained to understand the structure of the project management. Therefore, in our experiment in China, students with project management background were trained with a Systems Dynamics principle and their performance of a specific project management decision was studied. The findings suggest that principles of system dynamics can help person understand the interactions in project better and then make better decisions.

Key words: System Dynamics, project management, education, decisions making

Acknowledgement

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Chapter 1   Introduction

Project management was introduced in China in 1981 in the construction of LUBUGE power station in Yunnan. With the quickly economic development, more and more product development project was guide be the idea of project management, especially in today's global, dynamic and competitive environment. As a result, more and more skilled project managers were demanded.

However, product development projects are becoming more complex. Projects are "complex" because they tend to have 1) multiple stage of design, procurement, construction and testing; interacting technical disciplines; organizations involved (prime and sub-contractors, vendors, design agent, customers, regulators); and possible sequences for accomplishing the work, 2) changes of customer requirements and performance priority (schedule, cost, technical); government regulations and standards; work scope; technologies; resource availability; and developer productivity and quality, 3) delays in discovering rework; experiencing the full effects and conditions that impact the project; in perceiving true project performance; and implementing management responses (Weil and Dalton, 1992).

Due to project complexity and uncertainty, it is difficult to satisfy its multiple objectives, and trade-offs are common phenomena in products development. For example, increase or change in functionality during development may compromise achievement of quality goals, or violate cost and time constraints (or all together). Therefore, project manager have to deal with all these "complexities" and can exercise a fine control over the development process so that products can be delivered in time and within budget. To do so, project manager must be trained to be able to make decisions involving trade-off. And as we know, the first step of people dealing with the problem understands the question quit well. To understand trade-offs between concurrent product goal sand management project schedule in its resource restriction, their relation with overall project goals (and constraints), and the underlying processes needs to be understood. That is to said, in our project management training, we need

to help our prospective project manager understand the complexity of the project, and interactions between elements firstly.

The outcomes of a complex project are often measured in terms such as cost, timeliness, and quality. However, it is difficult t to satisfy its multiple objectives because of the complexity of the project. Project manager have to make decisions involving trade-off consistently. Therefore, project manager must be trained to understand the complexity of project and make feasible decisions involving trade-off. However, evidence showed that the perspective project manager trained by this traditional method lost the overlook of the project, understanding of the complexity in project and inefficient management (Ding 2006). In traditional project management teaching, the main concept of project management is taught though some separate courses. In china, for example, cost control, quality control and time control are three independent courses and taught by different teachers in different semesters. Students may get high score in their separated course but fail to catch the key issue when three outcome goals working together. In the other side, causalities and relations between surrounding and project, segments are showed a linear and static, in this separated course. Learning based on this situation, students can not get the idea of whole system and they show some funny things in their final degree exam performance. To solve this, traditionally, teacher will show some examples to show the main idea of project management in the project management course which is major in the schedule planning with use of network-based tools, such as Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT), and Earned Value Method (EVM). Or, teacher will also introduce case study to ask student analyze the case by the concept they learn when there is enough lectures time for this course. In case study method, the main point of the comparison for this research, students are exposed to problematic situations that are expected to develop a conceptualization, for later putting theory in practice. Students that are then expected to make decisions and discuss them with their teachers and peers. Unfortunately, students also lose themselves in the complex surroundings. Learnt concepts based on these premises can mislead learners focus on part of the project and lost the whole map of project and the

ability to make decisions involving trade-off. Especially, in real word, it is difficult for students to understand the dynamics and integration behavior in project processing. As we know we use the Planed Value (PV in short) as a benchmark in our project management. In the project processing, we measured the Actual Cost（AC in short）and Earned Value (EV in short), then analysis the situation of project performance and make decisions. PV, AC and EV are also a integration and dynamics measurements of project. But after teaching project management in traditional way, it is found that students have difficult in grasp the knowledge of these important concept and can not give the correct curve of them. For example, some of students thought PV is the integrated value of activity not time. The base reason is that they did not got the idea of dynamics, integration and complexity.

Furthermore, because complexity is hard to comprehend, estimated and nearly impossible to calculate only in our minds, it is difficult for student to understand the complexity of project and the impacts of policy implementations in complex system. Changing students' mental models to understand and apply theory in real world with a broader view is something that requires different approaches, and technology can help to improve this.

Creating new method to correct these misperceptions generated by "separated, linear and static thinking teaching" is not easy. Fortunately, the process of project management can be conceptualized as a complex information feedback system and System Dynamics can be used as a tool to understand the complexity and dynamics. Is System Dynamics an alternative method to improve their students' understanding of the impact of management decisions on the complex system?   The use of system dynamics models for project management decision making has a long research tradition. (Roberts 1964; Ford 1991; Lee 2007). And, system dynamics is also proved to a base model for designing the interactive learning environment for student. It is my hypothesis that it will give students a more realistic point by helping them to test their idea and obtaining some real feasible results. Because of the practical constraints of a course, it is difficult for students to experience realistic, large-scale industrial

development projects in which they could measure their study. But only simulator can not show the base structure of project management and made students change their mental model. System dynamics, as a useful tool to facilitate people understanding the complex world, can be a way to systematically explore and analyze the complex mutual interrelations of project, process, people, and products development. From this point, it is worth enough for us to explore the impact of using SD approach to enhance the understanding of the complexity in project management and improve the performance of project management decision-making.   Here ,the empirical study will be carried out to investigate the impact of SD on project management education.

As we know, it is difficult to introduce all characters of complexity in one experiment. We just focus on dynamics and accumulation in our experiment study for the benchmark of project control is the dynamic curve which is accumulation of resources. And in writers' teaching experience, undergraduate students have difficulties in understanding this benchmark.

Here, we will try to answer the question "Does SD-based teaching improve project manager decision making?" by project management teaching experiment. This question will divided into two sub-questions: 1)Does SD-based teaching help students establish dynamic mental model on project management? 2）Does SD-based teaching improve the understanding of the complexity of the project management?

Laboratory experiments composed of teaching sessions using SD methods were conducted to test three main null hypotheses. The first two hypothesis question whether SD can help people understand the dynamics of the problem. The last hypothesis aims to test the improvement of performance over the course of the teaching sessions.

One project in Chinese context will use as case to test in our experiment. A pre-test, a pro-test and a post-test will be applied to obtain reference data that facilitate comparison and analysis of the results. The experiment is expected to demonstrate an SD based training approach improves the performance, and find segments that SD based training real work well and how it work.

The paper is structured as follows: Section 2 presents the literature review. Section 3 will introduces the design of experiment with main hypothesis to support our research question and experiment. Section 4 provides an analysis of our experiment. Section 5 discusses the result of our experiment. Section 6 conclude whole thesis and explains the future work.

Chapter 2   Literature Review

2.1. Project Management and it's System Dynamics Model

Project management is at once one of the most important and most poorly understood areas of management. Delays and cost overruns are the rule rather than the exception in construction, defenses, power generation, aerospace, product development, software, and other areas. Many of the applications of system dynamics, in both academic research and consulting, involve the quantitative assessment of the costs and benefits of various programs, both retrospectively and prospectively. System dynamics models are widely used in project management to manage projects more effectively and to assess the magnitude and sources of cost and schedule overruns in the context of litigation. (Sterman 1992). There have been a number of applications to product development project management. The first system dynamics model in project management was proposed by Roberts (1964) to explore the basic dynamics of R&D projects. In this model , concepts of perceived progress and real progress were first introduced, addressing explicitly the fact that managerial decisions are based on perceptions which may be at significant variance with reality. The trade-off between the managerial decisions of allowing schedule slippage and hiring more staff has been modelled by Richardson and Pugh (1981) and Abdel-Hamid and Madnick (1991).

Flaw generation and rework were modeled by Abdel-Hamid and Madnick (1991) and Ford (1995, 1997,1999). System dynamics models provide a useful tool for a more systematic management of these strategic issues and could be used to find an optimum trade-off between the two extreme policies, giving an optimal project extension (Williams TM, 1999). And recently, The system integrates a fuzzy logic-based change prediction model with the system dynamics model of the Dynamic Planning and control Methodology (DPM) to study both the strategic and the operational aspects of project management based on the identified dynamics of a project and the change of project management(Lee SH 2006; Lee S 2006; Motawa IA 2007).

From these we can conclude that System dynamics have long history in modeling

the behavior of project management. The existing lectures have successfully described many aspects of development project management. But few literatures describe in adequate detail to help project manager understand the complexity of project and make decisions and feedback of their decisions. For example, in software project study, a Virtual Software Engineering Laboratory (VSEL) to be established based on system dynamics model to support product-focused trade-off analyses(Munch J, Pfahl D 2005).Their work paid more attention on the simulation and show the effectiveness of VSEL, and did not explore the relationship between elements. That is said; they used the System dynamics as a modeling tool not a teaching tool to help people the understanding decisions making involving trade-off, and people will use VSEL as a tool to see the performance of their decision but they still do know the complexity of the project quit well. It seems that how to make the project manager understand the complexity of project is the question of project management education. In the following paragraph, we will discuss the project management education via system dynamics.

2.2. Project Management education and System Dynamics utility

Product development is a dynamic and complex process since many interacting factors throughout the lifecycle impact the costs and schedule of the development project as well as the quality of product. To monitor and control development projects, management experience and knowledge on how to balance the various influential factors are required. The report in the software industry show inadequate project management. The most recent model IS teaching curriculum developed by consortium of industry and educational professional advocate increased emphasis on project management (PM) and even includes an entire course emphasizing PM concepts and practice. However, the growing pervasiveness of new product and the increasing number of development projects result in a lack of well-trained and experienced managers (Harry, 2005). In university teaching, teachers often use sample or case study to help student understand the concepts of project management, but it is difficult to help student to form the ability to make feasible decision because of the complexity

of the project. To address these issues, process simulation techniques became one trend in software project management education, starting with the pioneering work of Kellner and Hansen (1989) and Abdel-Hamid and Madnick (1991). In the last decades, the potential of simulation models for the training of managers has been recognized (Graham et al., 1992; Milling, 1995), some experience with process simulation as a means for software project management education and training has rarely been published (examples are Drappa and Ludewig, 1999;Madachy and Tarbet 1999), and a few experimental studies have been conducted involving the use of models that simulate the typical behavior of software projects (Lin, 1993; Lin et al., 1997;Smith et al.,1993).The results of these experiments indicate that a natural one-way causal thinking could be detrimental to the success of software managers. They must rather adopt a multi-causal or systems thinking. Moreover, they must be aware of feedback to their management decisions. These findings highlight the need for new learning and education strategies. Pfahl presented the results of a controlled experiment and its first external replication to investigate the effectiveness of computer-based training in the field of software project management using a system dynamics (SD) simulation model. While the experiment was originally performed at the University of Kaiserslautern, Germany (Pfahl et al., 2001) its replication took place at the University of Oulu, Finland. Both empirical studies are viewed as exploratory. And then they evaluated the learning effectiveness of using simulations in software project management education by replicated experiment to show that experiments in the sense that using SD models increase the interest of the subject in software project management and also improve students' knowledge of typical behaviour patterns. Hence, SD models represent a viable path for learning multi- causal thinking in software project management. This was supported by the subjective evaluation of the role-play scenario involving simulation with the SD model, which received very high scores. (Pfahl et al., 2003, Munch J 2005).

Obviously, forgoing study accentuated the effectiveness of simulator in project management education, and system dynamics is used as a modelling tool more than teaching tool. In their experiment, the control group did not have chance to play role

in the simulator. The results of experiment showed that the simulator based on system dynamics is more effective. The benefit of play role in simulator is that students can gain a deep approach to learning, enabling students to develop critical understanding and active learning. In a deep approach to learning, the students understand the subject in a personally meaningful way, engaging their own experience and their previous knowledge in an interactive process with the relevant context, logic, and existing evidence of the subject(Rodriguez D et al. 2006). This could be partially compensated by making students use process simulation models that reproduce the behavior of realistic (i.e., complex) development projects. From their experiment, we can not conclude that which one really works in improving the students' performance in their experiment, system dynamics, simulator, or both. To make good decisions, people must understand the problem quit well. But from foregone studies ,we can find that system dynamics was used as a modeling tool more than a tool to understand the complexity of project in our education or research. Even, students can learn by their experience in play role in simulator, but they can not explain why the system produce that behave they face to. That it is means, simulator just give the students a chance to do field work in invented project. In these sense, students still lost the whole map of the system and have no idea about the structure of system. What can we do for them? As we know, we can not expected all the project manager will be a system modeler, but we can help to them use system thinking when they making decisions. So, just as the great Chinese educationist-Confucius said: "teaching fishing is better than giving fish", the purpose of our study is to find some method can help students understanding the project management and training them to make feasible decision.

This research will pay more attention to the role of system dynamics in the project management education via more detailed descriptions of the dynamic feedback structures that drive project progress and schedule management based on principle of SD (e.g. feedback, delay, nonlinearity, etc) and tools of SD (causal loop diagram, stock and flow, ILE, etc). Furthermore, foregoing experiments are focus on the software project management, and there is no similar study in construction project

management or some other products development project. Here we will focus on the common ground in project management in teaching the students who are major in project management. We hope that with this new teaching method, prospective project managers will discover how project management work and make feasible decisions.

Chapter 3　　Experiment Design

An exploratory experiment is designed to measure the effectiveness of a brief SD-based teaching session in Project Management on facilitating learning about the complexity that arises from basic stock-and-flow relationships in a controlled environment. A pilot experiment was conducted at the Fuzhou University in China in Sep.2007 and December 2007. The preliminary analysis of the results raised the need of additional experiments, implying changes in teaching material, procedures and test instruments. Then, the experiment was conducted in April 2008 at the same university. The maximum allotted time for the entire teaching – testing session was two hours and a half. The participants were different, even though their characteristics are similar.

3.1. Research method

The chosen method of research is a laboratory experiment. For this research, a "Within subjects" design is used. The general procedures of the experiment have three parts. The first one aims at assessing subjects' prior understanding by engaging them in two different questions: "Bath Tub Question" (BT) and "Labor Curve question" (LC). In the second part, the experimental session alternates teaching and testing. On the one hand, the objective of teaching is to modify subjects' mental models and develop their ability to understand complexity and infer dynamic behavior. For this, the Schedule Question (SQ) is introduced. This process is facilitated by a teaching method that relies on SD basic concepts, tools and techniques and draws on analogical reasoning principles. On the other hand, testing aims at show whether subjects can transfer the understanding complexity to understand the behavior of project management after whole teaching. Thus, the session is divided into two phases, each of which is preceded and followed by tests. Finally, the post-teaching understanding is assessed using labor curve questions. Table 3.1 summarizes the sequence of activities.

Table 3.1 The sequence of experiment

General Procedures	Teaching Instruction	Testing	Test Instrument
1. Assessing prior understanding		Test-1	BT, LC
2. Teaching – Testing Process	Phase 1	Test -2	BT, SQ
	Phase 2	Test -3	SQ
3. Assessing post understanding		Test -3	LC

3.2. Test instruments

Subjects were engaged in three questions intended to measure their understanding of the complexity involved in basic structures that relate project management; as well as their dynamic behavioral intuition. The questions require that subjects infer the behavior of complexity such as the Bath Tub, Employees and Inventories (Sterman, 2000; Warren, 2002, 2005). Then, subjects will be asked some behavioral questions people continuously face when project management.

3.2.1. Bath Tub Question

The Bath Tub Question is performed before and in the teaching session. This is taken from the System Thinking Inventory designed by Sweeney and Sterman (2000), modified its flows and translated into Chinese. The original English version is presented in Appendix A. This story is familiar to the subjects. Subjects are given a diagram suggesting the simple structure that relates the quantity in Bath tub and two flows: inflows and outflows. This structure is depicted by the stock-and-flow diagram in Figure3.1. Information on these flows per minute is given graphically. From this information, students are prompted to draw the time path for the quantity in the stock (the contents of the bathtub).
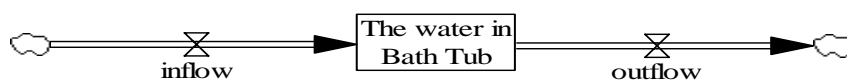
Figure 3.1. Underlying structure of the Bath Tub question

Both flows in and out of the Bath tub are exogenous. Inflow change according to a nonlinearly function while outflow remain constant as shown in Figure 3.2. Therefore, the net flow is changeable during each segment and no feedback process is considered. It makes the stock changes linearly and symmetrically over the segments. Figure 3.3 illustrates the correct answer to the question.

Inflow and outflow of Bath tub

inflow :　　　　　　　　　　　　　　　　　　　　　　　　Liter/Minute
outflow :　　　　　　　　　　　　　　　　　　　　　　　　Liter/Minute
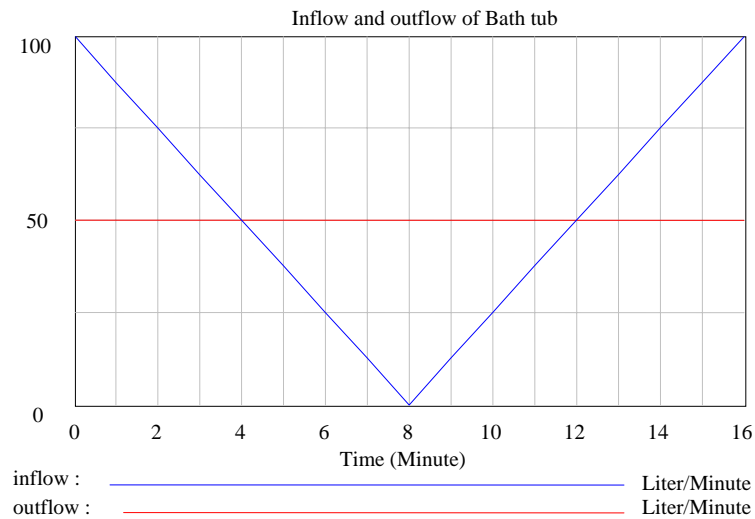
Figure 3.2. Pattern of the flows into the *Bath Tub* in the *Bath Tub question*

The water in Bath Tub

The water in Bath Tub :　　　　　　　　　　　　　　　Liter
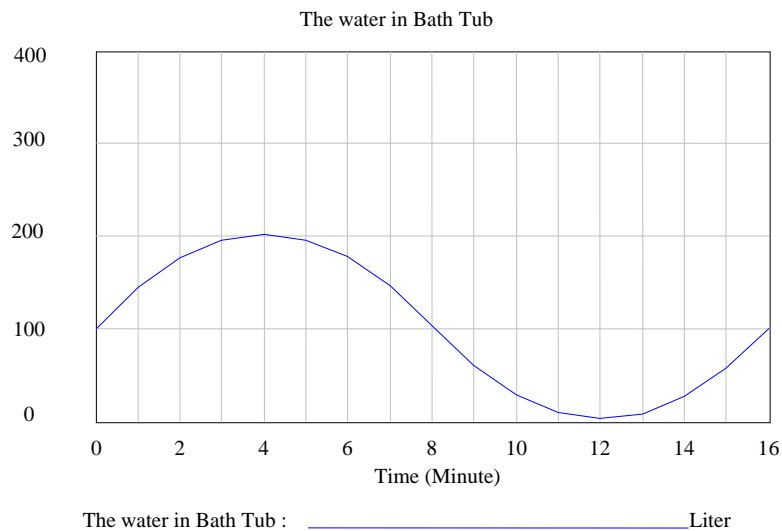
Figure 3.3. Correct answer to the *Bath Tub question*

3.2.2. Schedule Question

The Schedule question has been developed by the author, taking into consideration the design of the system thinking questions proposed by Sweeney and

Sterman (2000). The translation of the question into English is presented in the Appendix B. Subjects are given two stock structure, one of which relates one stock with two flows, the other of which relates one stock with one flows. These stocks are Employees and Project done work. Besides, information about how Employees constrains the rate of Production is indicated textually. The stock-and-flow diagram in Figure 3.4 represents the underlying second order structure.
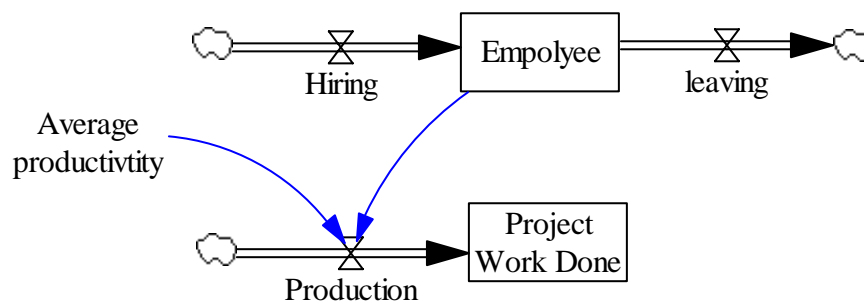
Figure 3.4.   Stock-and-flow representation of the underlying structure of the Schedule question.

The question is composed of two parts. The first part asks subjects to infer about the development of Employees from information on hiring and leaving rates per week. The second part asks first for describing the inflow pattern (Production) and, then, the project done work trajectory. The last trajectory is drawn from the assumed Production pattern. In the first part, the flows in and out of Employees are exogenous and constant over each segment. The hiring rate changes every five weeks and, therefore, exhibits a step pattern (Figure 3.5). This rate equals Leaving during the first and the last segments. It is either higher or lower over the other two segments, which are symmetric. Thus, the correct Employees trajectory initially keeps constant at the initial value, then increases and decreases linearly until reaches the equilibrium. This stock remains at this value afterwards. The correct answer is shown in Figure 3.6.

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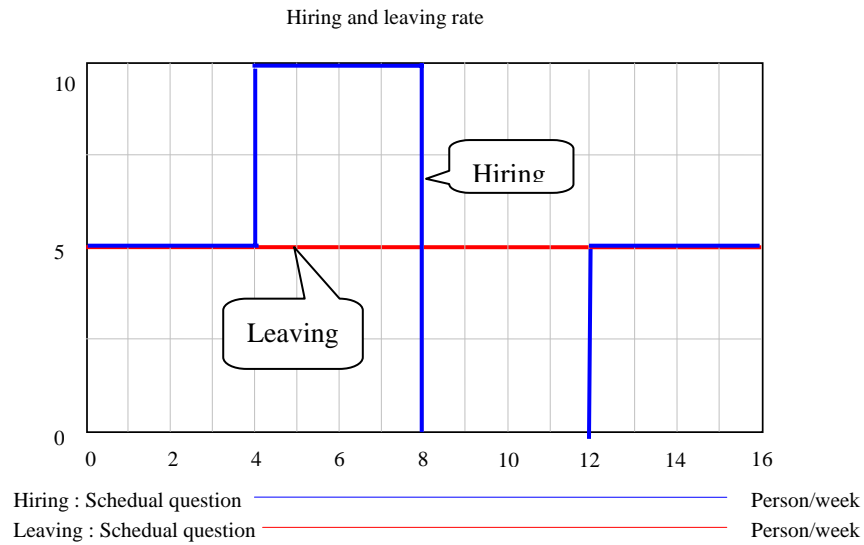
Figure 3.5. Pattern of the flows into the Employees in the Schedule question
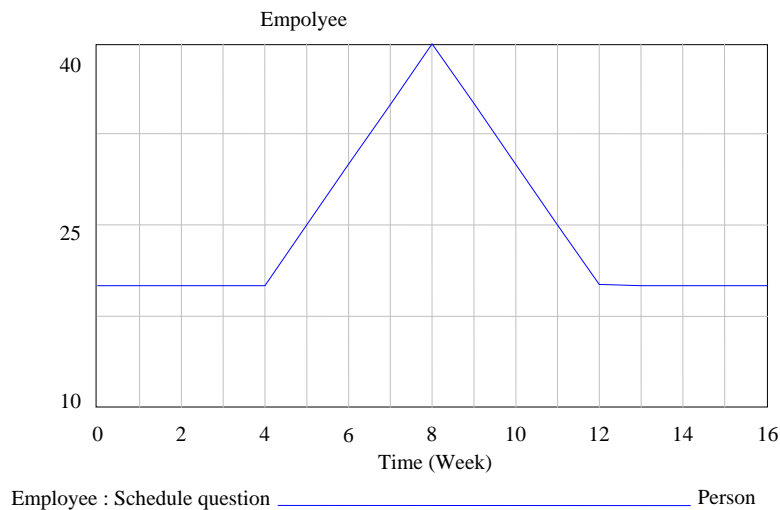
Figure 3.6. Correct behavior of Employees in Schedule question-Part I.

In the second part, the inflow into the Project Work Done follows the pattern of Employees, but it is amplified according to the average units produced by employee per week. The Production pattern depends on subjects' description of the behavior of Employees in Part I, their awareness of the link between Employees and Production and whether they count accurately the initial value.

Figure 3.7 illustrates the inflow of project done work, assuming the correct inference about Production trajectory. The correct pattern of the Project Done Work is shown in Figure 3.8. This stock keeps constant over the first and the last segments

while it increases during the rest of the time horizon at either an increasing or a decreasing rate.

Production

0.1

0.07

0.04

0   2   4   6   8   10   12   14   16
Time (Week)

Production: Schedule question ————————————————Unit/Week
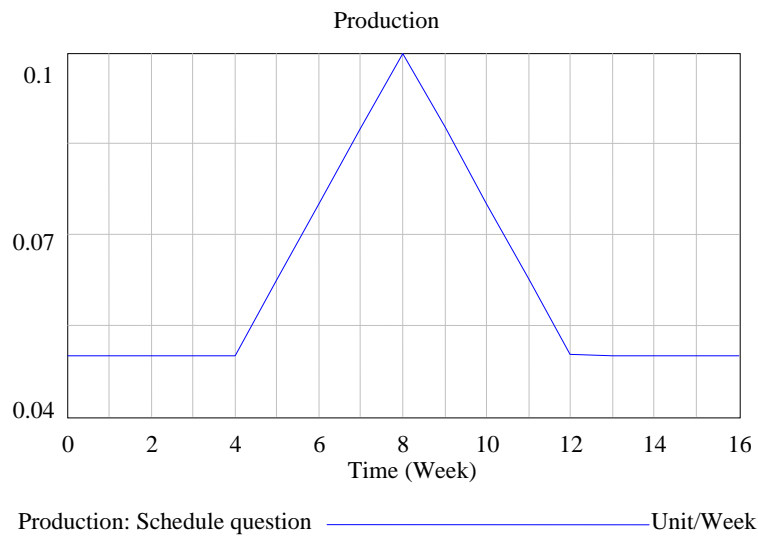
Figure 3.7. Flow patterns into the Project Work Done in the Schedule question

Project Work Done

2

1

0

0   2   4   6   8   10   12   14   16
Time (Week)

Project Work Done: Schedule question ————————————— Unit
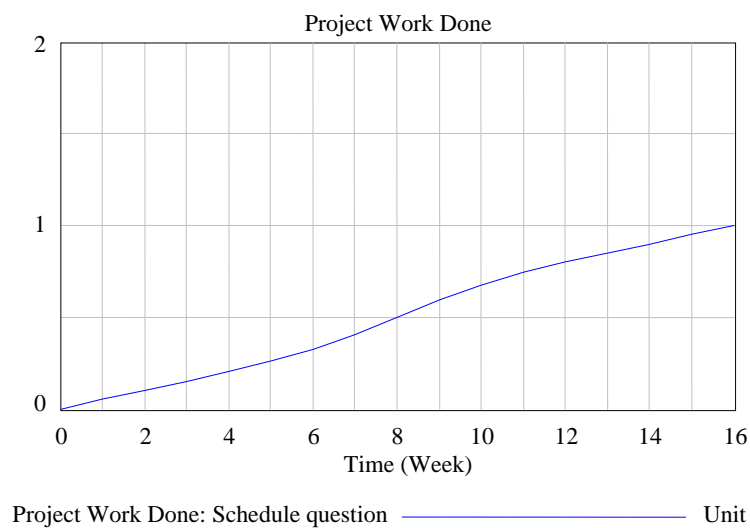
Figure 3.8. Correct behavior of Project Work Done in Schedule question-Part II.

The Schedule question assesses subjects' awareness of not only the simplest connection between a resource and its own flows but also a higher order structure. The interdependence between resources and the parabolic behavior of the second resource imply a higher level of dynamic complexity. However, this is still a simple question focused on stock and-flow relationships without including feedback processes. This question makes subjects face the same basic behavioral question when testing their dynamic intuition.

3.2.3. Labor Curve Question

In PMBOK2004 (Project Management Body of Knowledge), the benchmark of project cost and schedule management is the Planed Value (PV in short). As we know, the key point in many project cost and schedule management is human resources. And in Chinese project management course, Planed Value is also called Labor curve. So, the Labor curve question has been developed by the author based on the project relationship between project schedule and project human resource. The translation of the question into English is presented in the Appendix C. Subjects are given a case and ask to draw the Resources Gantt Chart and Labor curve. There is no stock and flow in this question. It is designed to test the ability of subjects' project management. Characters of activities are showed in Table 3.2. The correct answer of Resources Gantt Chart and Labor curve see Figure3.9 and Figure3.10. From the Figure3.10, the labor curve in project is accumulation of Resources Gantt Chart.

Table 3.2 Characters of activities in project X

Activity	Start to Start	Finish to start	Labor occupied	Duration(weeks)
A	B		10	2
B	A		20	1
C		B	20	3
D		A	15	4
E		C	25	4
F		D	20	4

Activity	01	02	03	04	05	06	07	08	09	10
A	10									
B	20									
C		20								
D			15							
E					25					
F							20			

Figure3.9 Correct answer of Resources Gantt Chart
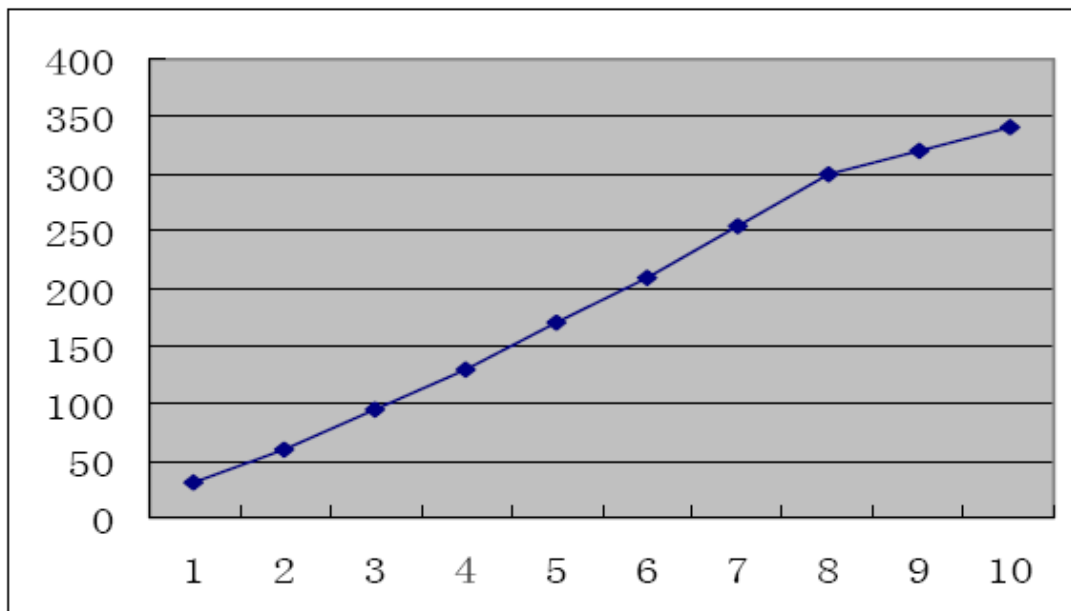
Figure3.10 Correct answer of Labor curve

3.3. Teaching strategy

3.3.1. Target concepts – Generic structures

The central concepts that should be taught to achieve this teaching challenge are stock and flows, especially the concept of dynamics, delay, nonlinearity and accumulation. They correspond to the most basic SD building blocks. The primary conceptual structure for the teaching session is shown in Figure 3.10. It depicts the

connections between a stock and its own flows. The second order structure that captures the indirect relationship between two stock is shown in Figure 3.11.
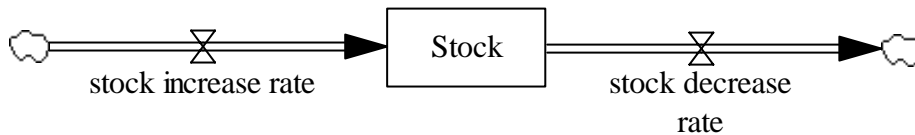
Figure 3.10. Primary structure of the teaching session
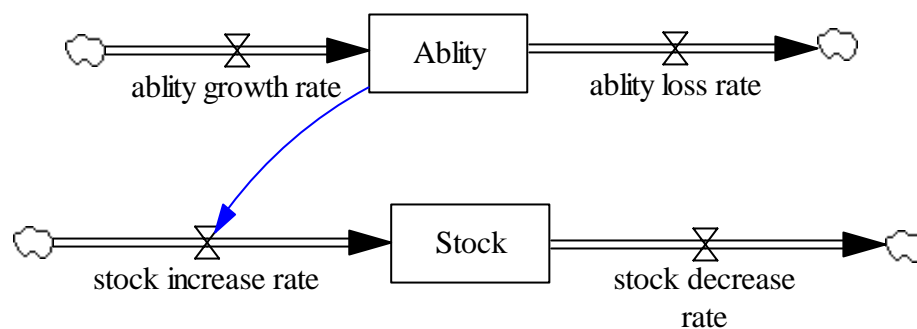
Figure 3.11. Second order structure of the teaching session

SD elements are gradually introduced to the subjects in two phases. The relevance of the concepts is supported by previous experiments' findings on the most common difficulties people have when relating stocks and flows and inferring the attendant behavior (Sterman & Sweeney, 2002; Kainz and Ossimitz, 2002; Ossimitz, 2002; Sterman, 2002; Pala & Vennix, 2005). Table 3.3 indicates the phase of the teaching session in which concepts are introduced for the first time. It also indicates the structures, type of behavioral patterns, skills and SD aids that are involved in each stage.

Table 3.3. SD elements involved in each phase of the teaching session.

	Phase 1	Phase 2
Concepts	Stocks	Second order system
	Flows – accumulation rates	Links
	Stock-and-flow relationship	
	Net flow	
Structure	First order system	Second order system
Behavior	Net flow: Linear	Net flow: Linear
	Stock: Parabolic	Stock: Parabolic
SD Tools Stock representation	Bathtub	Bathtub analogy

	Bathtub analogy Stock-and-flow diagram	Bacteria Stock-and-flow diagram
Ability	Ability to discern between stocks and flows, Ability to identify the stock-and-flow relationship Ability to relate the net rate and the changes in the stock Ability to infer dynamic behavior from the structure: direction of change, shape and total change of the stock	Ability to discern second order system. Ability to infer dynamic behavior from the second order sytem structure. Ability to transfer the concept of system dynamics to understand the base behavior in project management.

3.3.2. Methodology – Teaching material design

The teaching method refers to learning as a gradual feedback process. It takes elements from the theory of analogical reasoning, which has been developed by science education research as means of promoting Conceptual Change (Gentner et al, 1997; Nersessian, 1992). According to this, we can uses an analogy to explain the learning goal. The connection between these two elements is made clearer for subjects by providing a examples in project management that has the same underlying structure. If there is still a gap between what has been taught and the learning goal, there may be a need for enriching the analogy by adding new elements. This cyclical process (Fig3.12) occurs over each phase until the learning goal is fully explained. The instruction starts teaching the most basic SD concept (Stock). It finishes explaining the behavior that arises from the relationship between a stock and its flows in second order system.
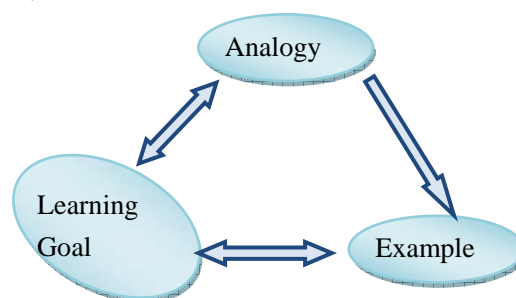
Figure 3.12. Cyclical Teaching process

The basic concepts of dynamics and complexity in project management are taught in SD language through an analogy.

The bathtub structure of one stock and two flows is used as an analogy to the

most basic elements of the project (resources and flows) and the simplest relationship between them. Besides, some important variables for business: debt, product price and customers orders are used examples to illustrate such structural similarities. For instance, debt of Project at any moment is the result of the accumulation of the money that have been borrowed minus the ones that have been repaid during a period of time. This accumulation is similar to the one that takes place when filling a bathtub.

The second order structure that depicts the connection between one resource and other's flow is beyond the scope of the bathtub analogy. The author expand the bathtub model with add the substance analogy. The relationship between substance in Bath tube and water in Bath tube is the number of bacteria in water. Once the resemblance between the primary and the bathtub structures is established in the two first phases, only the latter is used to teach the attendant dynamic behavior. With this structure in mind, students are expected to transfer the knowledge to a managerial context. Then, it demands their understanding of the underlying generic structure, as well as their awareness of its application to the typical relationships found throughout the project. Besides, sales man and inventory is also used as the example of second order system structure, which help students to understand the second order system in project more easier. Details of teaching material are pasted in Appendix D.

The teaching material includes stock-and-flow representations to depict structure and time charts to sketch the attendant behavior. Both diagrams are always displayed together when teaching about dynamic behavior in order to facilitate subjects' grasp of how it is generated by the structure. The use of both types of diagrams has long been encouraged in SD practice (Forrester, 1961; Richmond, 1993; Vennix, 1996; Sterman, 2000; Warren, 2005), especially in early stages of teaching and modeling.

3.4. Hypotheses

The main hypothesis intended to test whether there is a positive effect of a brief SD-based teaching session in Project Management on people's understanding of the dynamics involved in stock-and-flow relationship and then transfer this to project management.

Three null hypotheses are formulated in order to test statistically whether there is no significant effect of either the entire SD-based instruction or any of its phases on performance.

Let PBT, PST and PLC refer to the average performance in Bath Tub Question, Schedule Question and Labor Curve Question respectively. Then, the first null hypothesis is

H0,1: $PBT0 = PBT 1$

It implies no significant difference in performance before and after the instruction. The corresponding alternative hypothesis is:

H1,1: $PBT 0 \neq PBT 1$

Likewise, the second null and alternative hypotheses related to the Schedule Question are:

H0,2: $PST 0 = PST 1$

H1,2: $PST 0 \neq PST 1$

Finally, the third null hypothesis is:

H0,3: $PLC 0 = PLC 1$

It implies no effect of any of the phases of the instruction on performance of project management understanding. The corresponding alternative hypothesis refers to the difference in performance after the instruction:

H1,3: $PLC 0 \neq PLC 1$

There is significant different goal in these three null hypotheses. The first and second hypotheses are used to test whether there are improvement of system thinking ability after SD-based training. The third hypothesis is related to project management directly and used to study whether subjects' system thinking ability improving after SD-based training can help to improve their performance in project management.

3.5. Method of assessment

When evaluating the impact of the entire instruction, the assessment is based on the comparisons between the results got before and after the instruction for three

questions. For Bath Tub Question (BT) and Schedule Question(ST), subjects' understanding of the concepts associated with the stock-and-flow relationship and their intuitive ability to infer dynamic behavior is defined in terms of their average performance. For Labor Curve, subjects' understanding of the concepts associated with the base dynamic behavior of project management is also is defined in terms of their average performance. Therefore, the assessment of the experiment will separate in two.

3.5. 1 Assessment of BT and ST

In the BT and ST questions, the effectiveness of the Subjects' understanding of the concepts associated with the stock-and-flow relationship and their intuitive ability to infer dynamic behavior is defined in terms of their average performance Therefore, the effectiveness of the instruction is defined in terms of the improvement in those indicators. The average performance is estimated according to seven criteria set by

Sweeney and Sterman for their System Thinking Inventory research (2000). Table 3.4 describes the set of criteria. This table also indicates the features of behavior and the concepts that each criterion evaluates.

Table 3.4 Set of criteria for evaluating BT and ST

Feature of behavior	Concept Criterion	Criterion	Score
Direction of change	Accumulation - Positive net flow，Accumulation - Negative net flow , Accumulation –balance	1. When the inflow exceeds the outflow, the stock is rising. When the outflow exceeds the inflow, the stock is falling. When the outflow is equal to the inflow, the stock keep constant.	2 points every segment(four segments)
	Accumulation: Maximum and minimum	2. The peaks and troughs of the stock occur when the net flow crosses zero	2 points every peak (two peaks)
Shape	Continuity	3. The stock should not show any discontinuous jumps (It is continuous)	2 points every segment(four segments)
	Linear growth or Non-linear growth	4. When the net flow is constant , the stock must be rising (falling) linearly, and	2 points every segment(four segments)

		When the net flow is Linear changes, the stock must be rising (falling) Non-linearly	
	Net flow = stock's slope	5. The slope of the stock increases when Net flow increases, and decreases when Net flow decreases	2 points every segment(four segments)
Total change	Total change in an interval = area bounded by the net rate over the interval	6. The quantity added to (removed from) the stock during each segment is the area enclosed by the net rate	2 every segment(four segments)
Initial Value	Initial Value	7. The start point of graph is (0, initial value)	2 points

The first three criteria measure the awareness of accumulation over time. The fourth criterion evaluates the awareness of the continuity in the stock trajectory. The rest of the criteria assess the ability to relate the net rate and the changes in the stock both qualitatively (criterion 5) and quantitatively (criteria 6 and 7).

3.5. 2 Assessment of LC question

In the Labor curve (LC) question, the effectiveness of the Subjects' understanding associated with their understanding the base behavior of project management after training with the stock-and-flow relationship and inferring dynamic behavior is defined in terms of their average performance. Therefore, the effectiveness of the instruction is defined in terms of the improvement in those indicators. The average performance is estimated according to criteria set by the main project planning tool.

Table 3.5 describes the set of criteria. This table also indicates the features of behavior and the concepts that each criterion evaluates.

Table 3.5 Set of criteria for evaluating LC

Items	Concept Criterion	Criterion	Score
Dependency	Finish to start，	1. Activity X must start just after Activity Y	2 points every one(four in total)
	Start to Start	2. Activity X must start at the same time with Activity Y	2 points every one(one in total)
Time	Earliest start time	3. The Earliest start time of Activity Y is equal to the max value of all its Predecessor Activities	2 points every one(six in total)

	Earliest finish time	4. The Earliest finish time of Activity Y is equal to its Earliest finish time plus its duration.	2 points every one(six in total)
	Duration	5. The duration for Activity Y	2 points every one(six in total)
	Schedule	6. The duration for Critical Path	2 points every one(one in total)
Resources	Resource occupied	7. The quantity of resource need to finish Activity Y (Human resource: man/month)	2 points every one(six in total)
Labor curve	Human resource Value	8. The accumulation of Human resource at the end of month.	2 points every one(Ten in total)
	Time axis	9. The values of X axis	2 points every one(Ten in total)
	Line	10. the line connect the adjacent points	2 points every one(Ten in total)

The first two criteria measure the awareness of dependency of the activities. The fourth to sixth criterion evaluates the ability to calculate the schedule of the project. The Seventh assess the relationship between resource and schedule. The last one estimates the ability to accumulate the Human resource.

3.6. Subjects

Two hundred and seventeen students participated voluntarily in the experiment. They were invited in their classrooms while attending courses in IT Project Management and construction project management at the Fuzhou University, China. For the limit of class room space, the experiment was divided in two. That means, we conducted experiment in April 22 and April 27. And subjects were asked to join experiment randomly. Subjects were not paid.

In the beginning of the session, subjects were asked for information about their current program, age, gender and whether they had any previous knowledge in System Dynamics. Table 3.6 summarize subjects' characteristics and the previous courses attended, respectively. All of them have knowledge in mathematical integration, and project management.

Table 3.6 Subjects' characteristics

Characteristics		# Subjects N=217	%
Age	20-21	139	64.06

	21-22	67	30.88
	>22	11	5.07
Gender	M	155	71.43
	F	62	28.57
Major	Construction Management	45	20.74
	Management of Information System	87	40.09
	Logistics Management	85	39.17
Level	4	30	13.82
	3	187	86.18
Previous knowledge of SD	YES	0	0.00
	NO	217	100.00

For the subjects are separate in two groups randomly, differences of characters of these two groups should be studied. Table 3.7 summarize differences of subjects' characteristics and the previous courses attended, respectively. The data of subjects characters is represented in Appendix E.

Table 3.7 Subjects' characteristics

Characteristics	Similar?
Age	Y[1]
Gender	Y
Major	Y
Level	Y
Previous knowledge of SD	Y（None of them have　Previous knowledge of SD

---

[1] Y: When P value >0.05 in ANOVA analysis, characters of these two groups are similar. Data and P-value are showed in appendix E.

Chapter 4   Results

In this sector, results of experiment are showed. And for the convenience of analysis, the performance of every criterion is normalized. The raw value of the performance is pasted in Appendix F-H. In experiment sequence, test 1 is pre-test of question 1 and question 3, test 2 is post-test of question1 and pre-test of question 3, and test3 is post-test of question 2 and question 3.

4.1. Bath Tub Question

4.1.1. Performance of every criterion

1.   Performance of Direction of change

（1）   Performance of criterion 1

From figure 4.1, we can see that subjects perform better in test 2 than in test 1. In Test 1, 76 subjects got zero, 31 subjects got 0.5 and 110 subjects got 1. That means only 50% of subjects got the right answer of criterion1 even they all have powerful background in math especially integral. After trained by the basic knowledge of system dynamics, subjects experienced better score. There are only 3 subjects who got zero who also got same score in the test 1. There are 10 subjects who got 0.5 in criterion 1 in test 2, which is less than 31subjects in test 1. In these 10 subjects, there 6 subjects got zero in test1, 3 subjects got 0.5 in test 1 and one subject got 1 in test 1. That subject may misapprehend the teaching materials. It is too little to effect the result of experiment. And there are 204 subjects who got 1 in test 2. The number of subjects increases 85%. Furthermore, 32% of them got zero in test 1 and 13% of them got 0.5 in test1. That means 46% of subjects perform better in test 2 than in test 1.
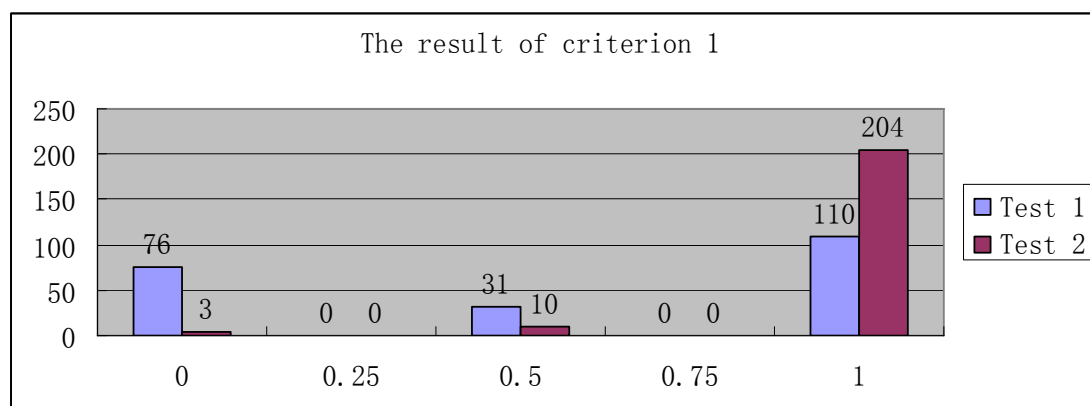
Figure 4.1 The result of criterion 1

（2）　Performance of criterion 2

As showing in figure4.2, subjects perform better in test 2 than in test 1. In Test 1, 76 subjects got zero and 141 subjects got 1. That means only 65% of subjects understand that the peaks and troughs of the stock occur when the net flow crosses zero. After teaching section 1, subjects earned better score. There are only 3 subjects who got zero who also got same score in the test 1. 214 subjects got right answer. That means 33% performed better in test 2 than in test 1.
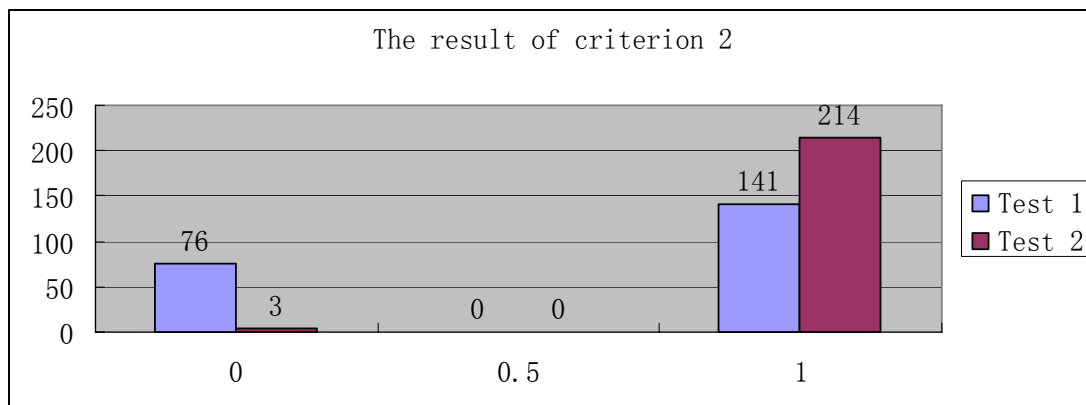
Figure 4.2 The result of criterion 2

Totally, from figure 4.3, we can find that 46% subjects (99 subjects) performed better, 54% subjects ((117 subjects) performed equally and only 1 subjects performed worse in the whole change of the performance of direction change, seeing figure 4.3.
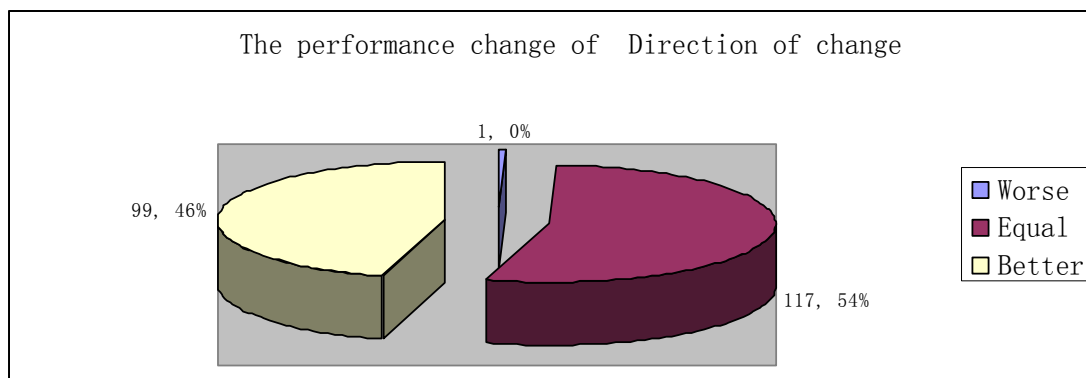
Figure 4.3 The performance change of Direction of change

2.　*Performance of Shape*

（1）　Performance of criterion 3

In the test 1, there are only 50% of subjects drew the graph of bath tub water as a

continue curve. 54 subjects drew four sharp in four segments. In 61 subjects answer, there is one segments is continue curve. After teaching section 1, 193 subjects got right answer but there are still 12 got zero, 2 subjects got 0.25 and 10 subjects got 0.5. In those subjects who earn zero, there are 6 subjects performed same in the test 1, 4 subjects got 0.25 and 2 subjects got 1 at beginning. From the whole results of criterion, nearly 49% of subjects (106 subjects) performed better after teaching section1, 47% of subjects (102 subjects) perform same in this teaching experience and 4% of subjects (9 subjects) did worse after teaching section1, seeing figure 4.4.
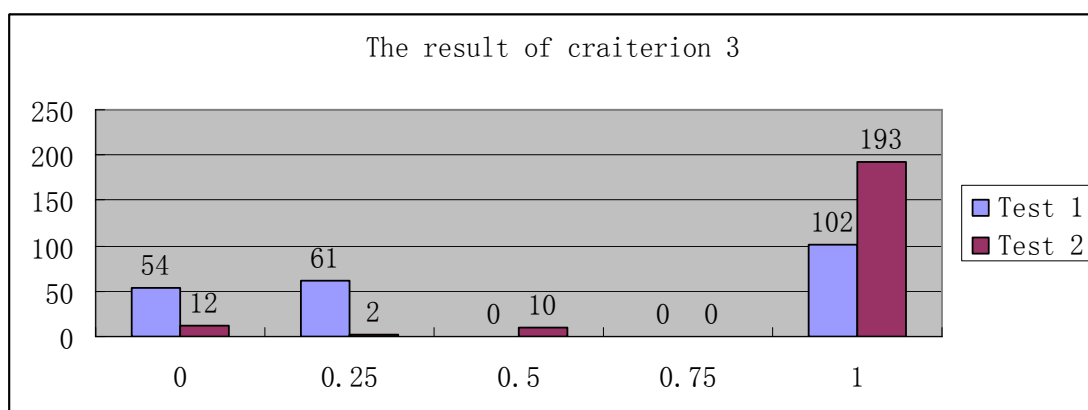
Figure 4.4 The result of criterion 3

（2） Performance of criterion 4

According the result of this criterion, there are 216 subjects understood the non-linear shape of the graph of the water in bath tub in test 2 while there are 154 subjects got it in test 1. There are only one subject got zero after teaching section 1. And 28% of subjects improved their score after teaching, see figure 4.5.

Figure 4.5 The result of criterion 4

（3）   Performance of criterion 5

After trained by the basic knowledge of system dynamics, subjects experienced better score, showing in figure 4.6. At the beginning, nearly 49% of subjects (106 subjects) got zero, 21% of subjects (46 subjects) got 0.5 and only 30% of subjects (65 subjects) got 1. In test 2, there are only 3% of subjects (8 subjects) who got zero, 5% of subjects (11 subjects) who got 0.5 and 92% of subjects (198 subjects) who got 1. In whole, 65% of subjects (139 subjects) improved their performance and 34% of subjects (75 subjects) performed the same, while 1% of subjects (3 subjects) performed worse after teaching section1.
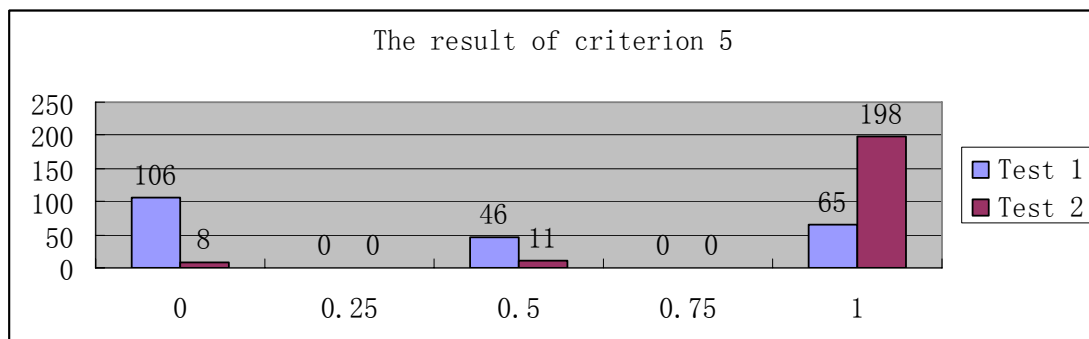
Figure 4.6 The result of criterion 5

After all, there are 67% subjects (145 subjects) who performed better, 31% subjects (68 subjects) who performed equally and only 4 subjects whoperformed worse in the whole change of the performance of direction change, seeing figure 4.7.
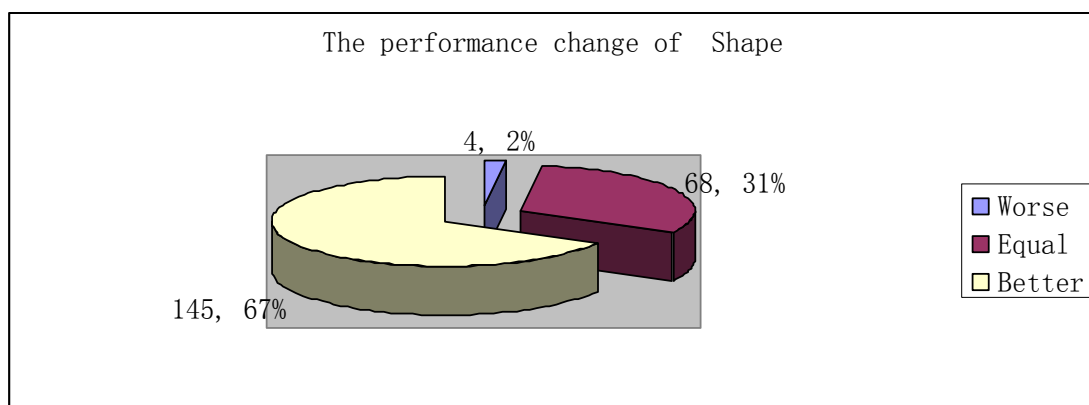
Figure 4.7 The performance change of Shape

3.   *Performance of Total change*

From answers of subjects, the performance of total change is the worst one in this question. Some of students even showed that the volume of water in bath tub was

negative. In Test 1, 123 subjects got zero, 9 subjects got 0.5, 24 subjects got 0.75 and 61subjects got 1. That means only 28% of subjects got the right answer of criterion 6 even they all have powerful background in math especially integral. After trained by the basic knowledge of system dynamics, subjects experienced better score. But there are still 28% of subjects (61 subjects) who got zero. Furthermore, there are 5% of subjects (12 subjects) got 1 and 4% of subjects (9 subjects) earned 0.75 in tes1, in these 61 subjects who got zero in test 2. At all, there are 49% of subjects (106 subjects) increased their score, 41% subjects (90 subjects) did the same and 10% subjects (21 subjects) performed worse after teaching section 1, seeing figure 4.8 and figure 4.9.
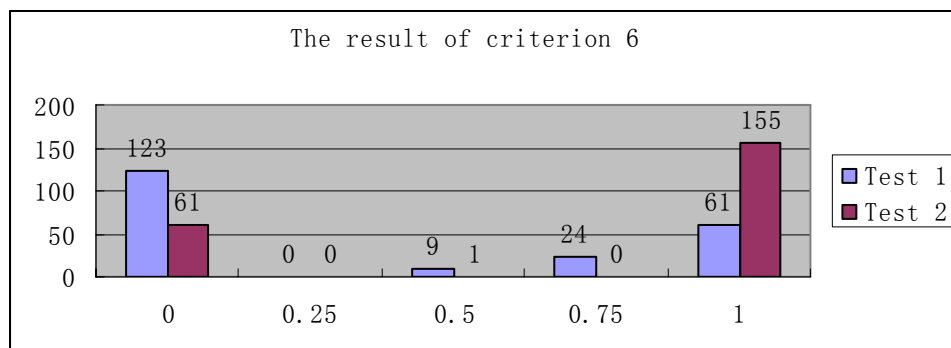
Figure 4.8 The result of criterion 6
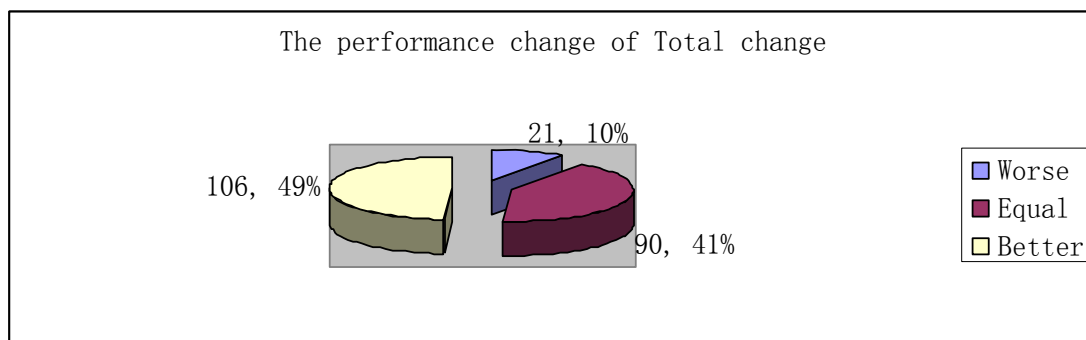
Figure 4.9 The performance change of Total change

4.   Performance of Initial Value

The performance of subjects becomes better after teaching section 1, showing in figure 4.10. In test 1, there are 35% subjects (76 subjects) used zero as the initial value in their answer. After trained, there are still 5% subjects (13 subjects) thought the initial value is zero while 54% of them (7 subjects) got the right initial value at the beginning. Totally, 32% subjects (70 subjects) improved their performance in test 2

while 3.2% (7 subjects) subjects performed worst, seeing figure 4.11.
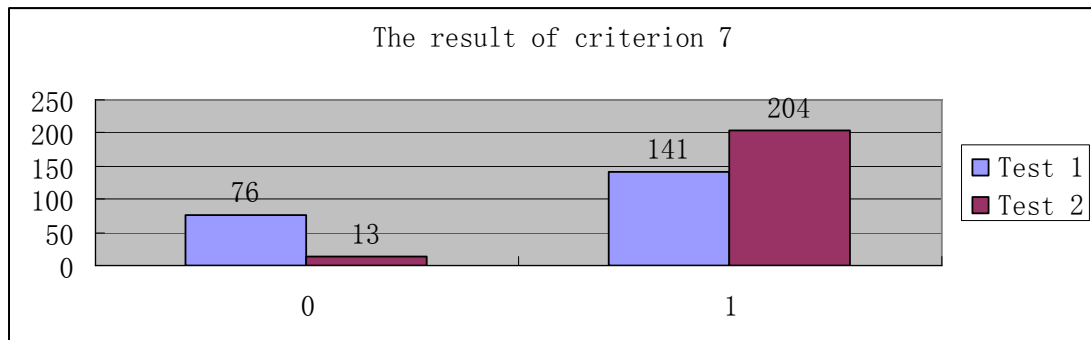
Figure 4.10 The result of criterion 7
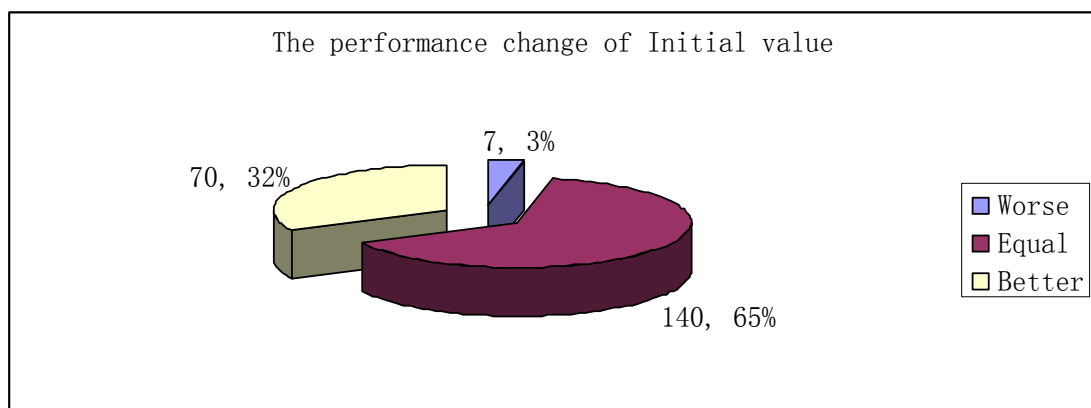
Figure 4.11 The performance change of Initial value

4.1.2. Average performance

1. Changes in performance

According to the result, subjects did poor at the beginning while average score is 54.8%. After teaching section 1, subjects reached an average score of 91.8%. Subjects did best showing the water in Bath Tub trajectory as a continuous curve reaching nearly 100%. The estimation of their awareness of the accumulation over time and the proper direction of the changes of the stock reaches around 99% of the maximum value, compared to only 58% in test1. The average performance on relating qualitatively the net flow and the slope of the Bath tub water trajectory increases from 38% to 94%. However, subjects perform not quit well relating quantitatively total changes in the stock in both tests. They get in average nearly 72% of the maximum score possible in the Post-test, compared to only 38% in the Pre-test. Figure 4.12 illustrates the comparison of results between tests by criteria.
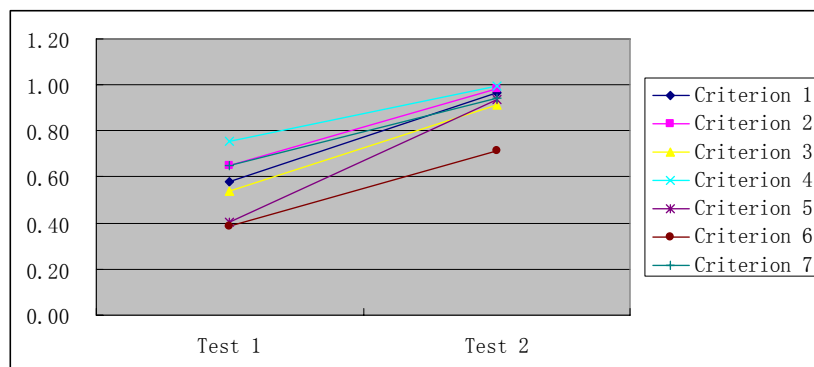
Figure 4.12 Average performance on the *Bath Tub Question* based on individual criteria

The analysis of the results indicates that the teaching session has had an influence on improving the performance of the subjects in the Bath Tub question. The overall average performance increases after the teaching session from 57% to 92% of the full mark. Table 4.1 shows the average performances before and after the session 1 (Test 1 and Test 2) by individual coding criteria and shows the absolute differences between them. Appendix F contains the raw data. Student-t statistics analysis is used to test whether the differences in performance are significant or not. According to these results, performance on all criteria is poor in the beginning. Nevertheless, the teaching session 1 leads to significant improvements in all the items.

Table 4.1 The Average performance in *Bath Tub Question* by coding individual criteria

	Test 1	Test 2	Difference	t Stat	P
Criterion 1	0.58	0.96	0.38	12.54	0.00
Criterion 2	0.65	0.99	0.34	10.46	0.00
Criterion 3	0.54	0.91	0.37	11.89	0.00
Criterion 4	0.76	1.00	0.24	9.17	0.00
Criterion 5	0.41	0.94	0.53	16.94	0.00
Criterion 6	0.38	0.72	0.34	8.08	0.00
Criterion 7	0.65	0.94	0.29	8.20	0.00
Mean of all item	0.57	0.92	0.36		
St Dev	0.14	0.09	0.09		
N	217	217			

2.   Levels of change in performance

（1）   Initial level of performance of question 1

Only 2.8% of subjects did the question correct and 97.8% of them performed part correct at the beginning. One third of them perform 60%-70%, and one fifth did

10%-20% . Figure 4.13 distributes subjects in ranges of performance according to their initial average score. This implies that most subjects have a high potential for learning from the teaching session.
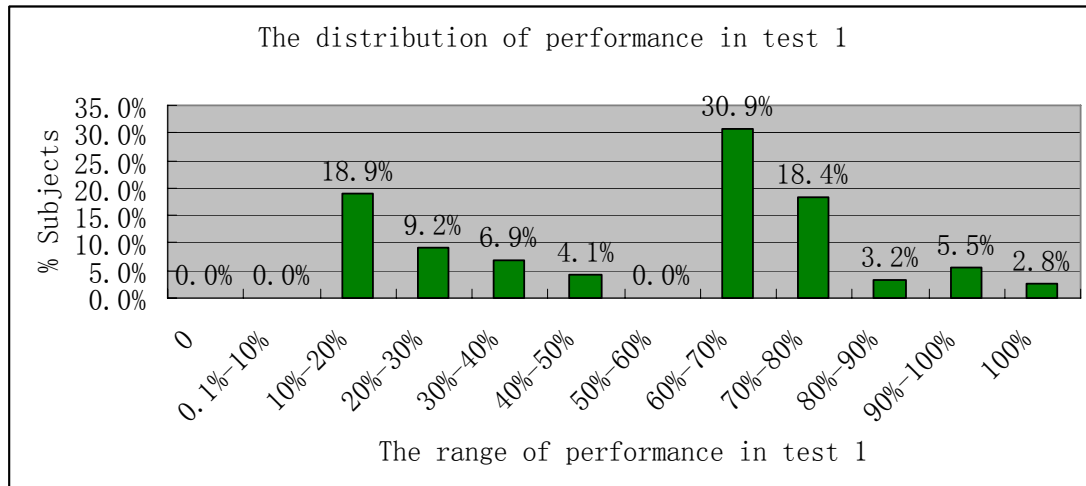
Figure 4.13 The distribution of performance in test 1

（2） Levels of change in performance

When comparing individual average scores between test 1 and test 2, it is found that about 93% of the subjects improved their performance and 6 % did equal in both tests. And only 1% perform slightly worse in the end. Figure 4.14 illustrates the resultant distribution.
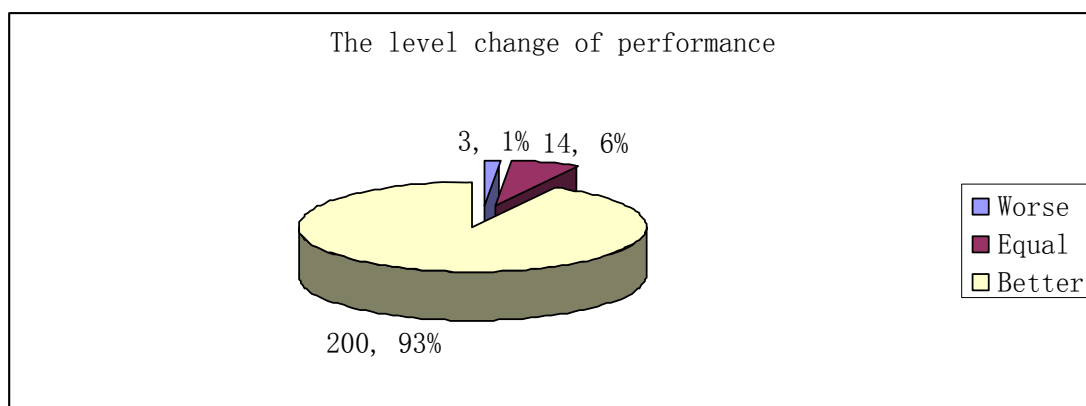
Figure 4.14 The level change of performance

（3） Improvement Efficiency of performance.

To know how much improvement subjects got, the Improvement Efficiency (IE in short) of performance is introduced here. IE is defined as:

$$IE = \frac{\text{The score of Post - test} - \text{The score of Pre - test}}{(\text{Full mark} - \text{The score of Pre - test})} \times 100\% \qquad (4\text{-}1)$$

For question 1, the pre-test is test 1 in the teaching experiment sequence, and the post-test is test 2. So, it is found that 53.5% of subjects improved 100% after teaching section 1. And, 1.4% did worse in test 2. There are 6.5% did equally in these two tests. The other 38.6% of subjects increased their scores ranging from 10% to 90%, most of which got 70-80% increases, seeing figure 4.15.
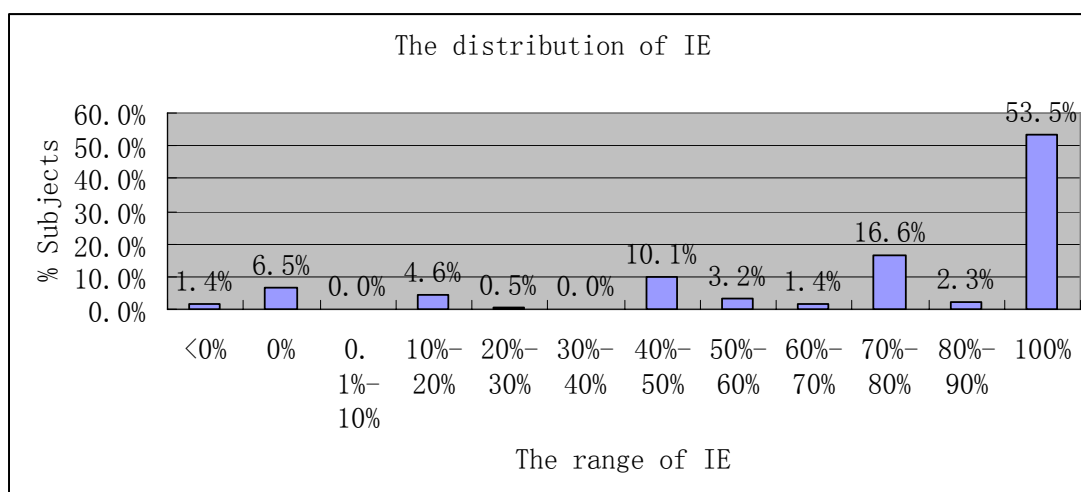
Figure 4.15 The distribution of IE

3. Performance changes related their mathematics background.

For there is no classroom to enclose 217 subjects, subjects are separated in two randomly. From their answer, it is found that they would like to write the math equations about question and then draw the curve. So, here we will compare their performance based on their performance in their math test. ANOVA analysis showed scores of these two groups are similar. Their initial score of math is showed in Appendix I.

Table 4.2 The performance in *Bath Tub related with math bacground*

	Improvement of question 1	Average Score of Math	Number
Goup 1	33.10%	77	110.0
Goup 2	40.20%	76.2	107.0

From table 4.2, we can find that average scores of math of these two groups are nearly same. The group1 got 33.1% improvement in question 1 while their average score of math is 77. Furthermore, the group 2 whose average score of math is 76.2,

got average 40.2% improvement of their performance in question1. Furthermore, ANOVA analysis suggested the P-value of these improvement of question 1 in groups is bigger than 0.05. It can be said that even they write the equations of the bath tub water but their performance of math have little influence on their work in question 1.

4.2. Schedule Question

4.2.1. Performance of the behavior of *Employees* stock

1.   Change in average Performance

Subjects' average score is 79%. After teaching section 2, subjects reached an average score of 94%. The estimation of their awareness of the accumulation over time and the proper direction of the changes of the stock reaches around 97% of the maximum value, compared to only 67% in test 2, showing that subjects did best. The average performance on relating the shapes of the employee trajectory increased from 84% to 94%. However, subjects performed not quit well relating quantitatively total changes in the stock in both tests. They get in average nearly 89% of the maximum score possible in the test 3, compared to only 77% in the test 2. Figure 4.16 illustrates the comparison of results between tests by criteria.
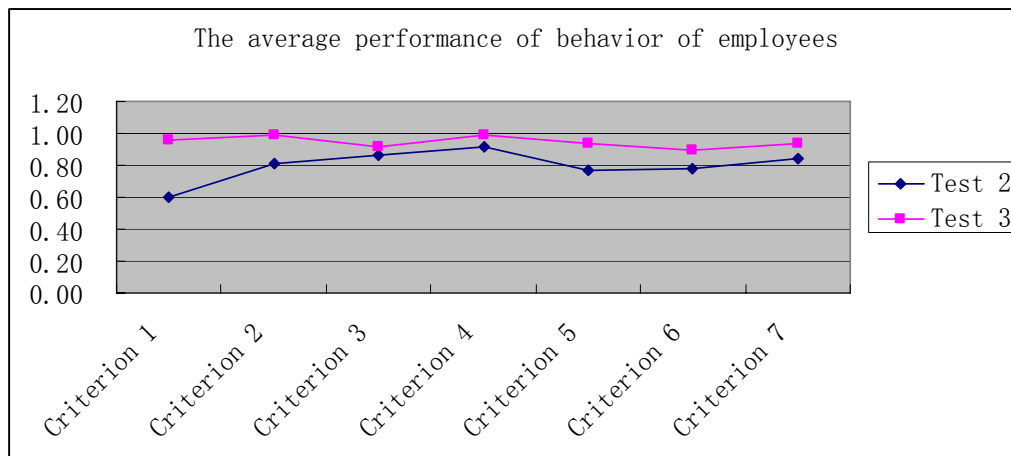
Figure 4.16 The comparison of performance between tests by criteria.

The analysis of the results indicates that the teaching session has had an influence on improving the performance of the subjects in the behaviour of employees in Schedule question. The overall average performance increases after the teaching session from 79% to 94% of the full mark. Table 4.2 shows the average performances

before and after the session 2(Test 2 and Test 3) by individual coding criteria and shows the absolute differences between them. Appendix *E* contains the raw data. Student-t statistics analysis is used to test whether the differences in performance are significant or not. According to these results, the teaching session 2 leads to significant improvements in all the items.

Table 4.3 The Average performance of behavior of employee by coding individual criteria

	Test 2	Test 3	Difference	t Stat	P
Criterion 1	0.60	0.96	0.36	15.62	0.00
Criterion 2	0.81	0.99	0.18	8.40	0.00
Criterion 3	0.86	0.91	0.05	4.58	0.00
Criterion 4	0.91	0.99	0.07	5.53	0.00
Criterion 5	0.77	0.94	0.17	9.11	0.00
Criterion 6	0.78	0.90	0.12	7.38	0.00
Criterion 7	0.84	0.94	0.10	4.81	0.00
Mean of all item	0.80	0.95	0.15		
St Dev	0.10	0.03	0.10		
N	217	217			

2. Levels of change in performance

（1） Initial level of performance of behavior of employee stock in question 2

Only 11% of subjects did the question correct and 89% of them performed part correct at the beginning. Most of those who did part correct performed 60%-100%, and went halves in these four ranges. Figure 4.17 distributed subjects in ranges of performance according to their initial average score. This implies that most subjects did better after they got some knowledge of system dynamics after teaching section 1, but they still have a potential for learning from the teaching session 2.
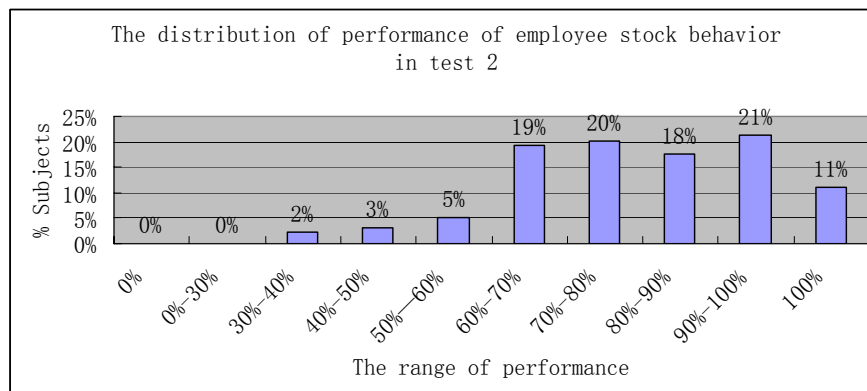
Figure 4.17 The distribution of performance of employee stock behavior in test 2

（2）　Levels of change in performance and Improvement Efficiency of performance.

For question 2, the pre-test is test 2 in the teaching experiment sequence, and the post-test is test 3.When comparing individual average scores between test 2 and test 3, it is found that about 86.5% of the subjects improved their performance and 13% did equal in both tests. And only 0.46% of subjects perform slightly are worse in the end. Here, Improvement Efficiency (IE in short) is also introduced. So, it is found that 56% of subjects improved 100% after teaching section 2. The other 30.4% of subjects increased their scores ranging from 10% to 90%, most of which got 30-40% increases, seeing figure 4.18.
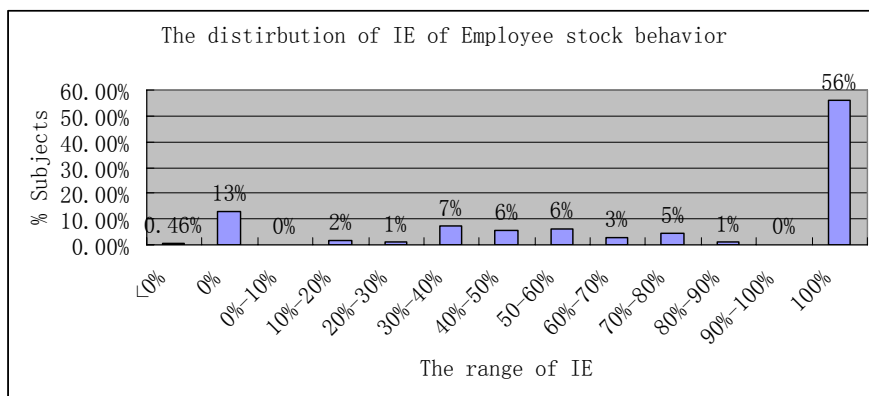
Figure 4.18 The distribution of IE of Employee stock behavior

4.2.2. Performance of the behavior of *Project Work Done* (PWD in short) stock

1.　Change in average Performance

At the beginning, subjects' average score is 48%. After teaching section 2, subjects reached an average score of 78%. The estimation of their awareness of the accumulation over time and the proper direction of the changes of the stock reaches around 90% of the maximum value, compared to only 31% in test 2, showing that subjects did best. The average performance on relating the shapes of the employee trajectory increased from 53% to 79%. However, subjects performed not quit well relating quantitatively total changes in the stock in both tests. They get in average nearly 65% of the maximum score possible in the test 3, compared to only 38% in the test 2. The performance of right initial value reached 70% while it was 65% in test 2. Figure 4.19 illustrates the comparison of results between tests by criteria.
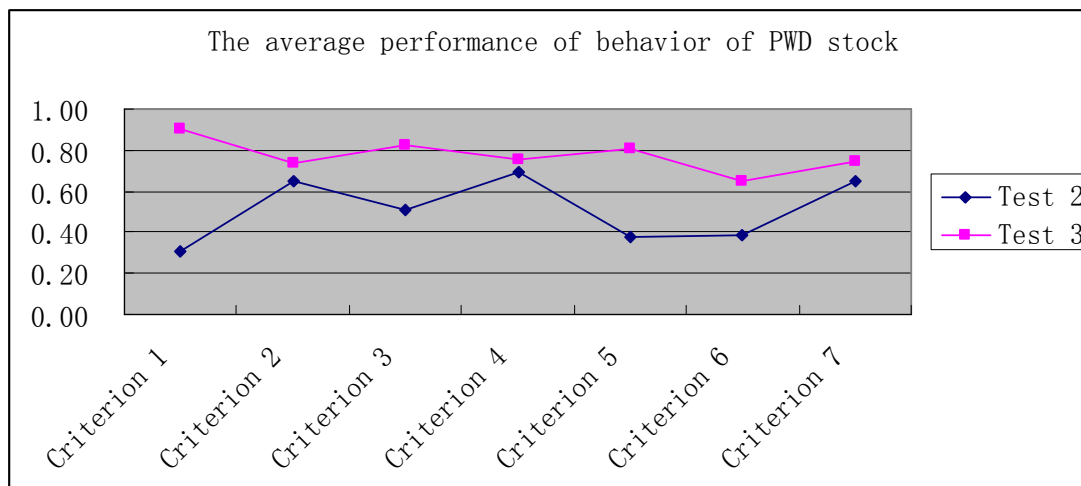
Figure 4.19 The comparison of performance between tests by criteria.

The analysis of the results indicates that the teaching session has had an influence on improving the performance of the subjects in the behaviour of project work done in Schedule question. The overall average performance increases after the teaching session from 48% to 78% of the full mark. Table 4.3 shows the average performances before and after the session 2(Test 2 and Test 3) by individual coding criteria and shows the absolute differences between them. Appendix G contains the raw data. Student-t statistics analysis is used to test whether the differences in performance are significant or not. According to these results, the teaching session 2 leads to significant improvements in all the items.

Table 4.4 The Average performance of behavior of PWD stock by coding individual criteria

	Test 2	Test 3	Difference	t Stat	P
Criterion 1	0.60	0.96	0.36	15.62	0.00
Criterion 2	0.81	0.99	0.18	8.40	0.00
Criterion 3	0.86	0.91	0.05	4.58	0.00
Criterion 4	0.91	0.99	0.07	5.53	0.00
Criterion 5	0.77	0.94	0.17	9.11	0.00
Criterion 6	0.78	0.90	0.12	7.38	0.00
Criterion 7	0.84	0.94	0.10	4.81	0.00
Mean of all item	0.80	0.95	0.15		
St Dev	0.10	0.03	0.10		
N	217	217			

2.   *Levels of change in performance*

（1）　Level of performance of behavior of PWD stock in test 2

None of subjects did the question correct at the beginning. Most of those who did part correct performed 60%-100%, and one fifth performed 20%-30%. Figure 4.20 indicates distributed subjects in ranges of performance according to their initial average score. This implies that most subjects did better after they got some knowledge of system dynamics after teaching section 1, but the second order system is strange to them. They have a high potential for learning from the teaching session 2.
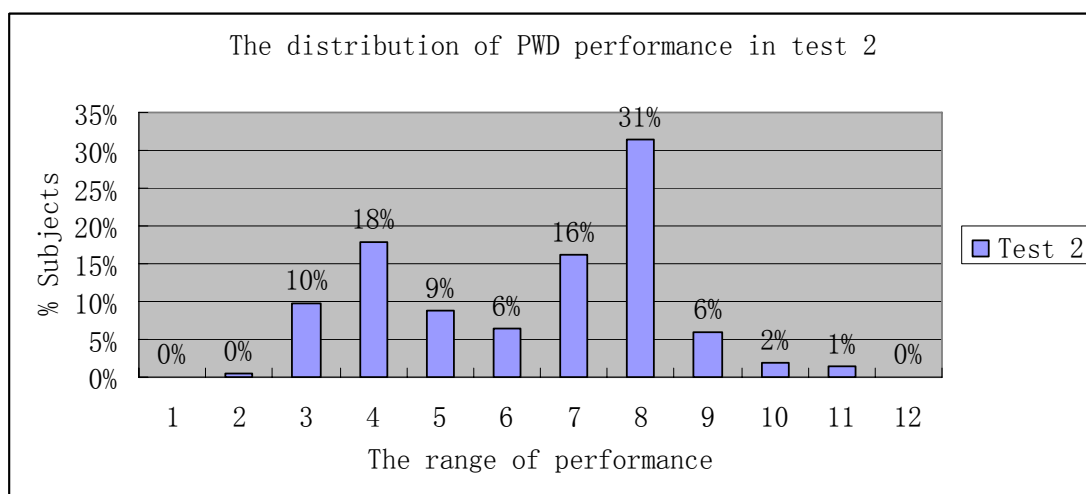
Figure 4.20 The distribution of performance of PWD stock behavior in test 2

（2）　Levels of change in performance and Improvement Efficiency of performance.

For question 2, the pre-test is test 2 in the teaching experiment sequence, and the post-test is test 3. After trained with the second order system, they performed better than before. 8% of them got the full mark. When comparing individual average scores between test 2 and test 3, it is found that about 94% of the subjects improved their performance and 6% did equal in both tests. Here, Improvement Efficiency (IE in short) is also introduced. So, it is found that 7.8% of subjects enjoyed 100% Improvement Efficiency after teaching section 2. The other 18.9% of subjects got their Improvement Efficiency ranging from 70% to 80%. In whole, 67.7% of which got more than 50% Improvement Efficiency while 26.3 % subjects got less than 50% Improvement Efficiency. Figure 4.21. indicates distributed subjects in ranges of performance according to their Improvement Efficiency.
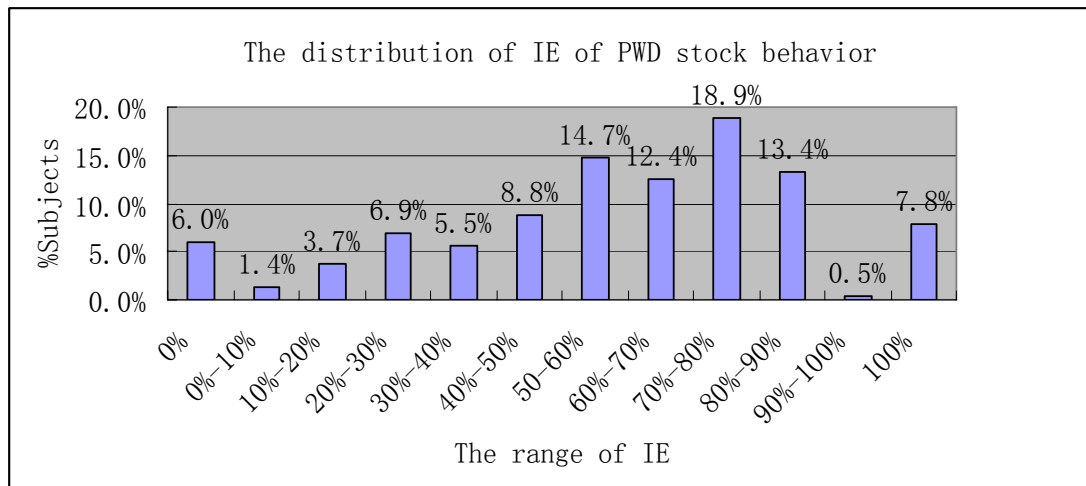
Figure 4.21 The distribution of IE of PWD stock behaviour

3.   *Performance changes related their mathematics background.*

Here we also compare their performance based on their performance in their math test.

Table 4.5 The performance in *Bath Tub related with math bacground*

	Improvement of question 2	Average Score of Math	Number
Goup 1	21.6%	77	110.0
Goup 2	8.7%	76.2	107.0

From table 4.5, we can find that average scores of math of these two groups are nearly same. The group1 got 21.7% improvement in question 1 while their average score of math is 77. Furthermore, the group 2 whose average score of math is 76.2, got average 8.7% improvement of their performance in question2. Furthermore, ANOVA analysis suggested the P-value of these improvement of question 3 in groups is bigger than 0.05. It can be said that t their performance of math have little influence on their work in question 2.

4.3. Labor Curve Question

4.3.1. Change in average Performance

In the beginning of the experiment, the average score is 46.7%. After teaching session, subjects reached an average score of 87%. The estimation of their awareness of the accumulation of the human resource in project process reaches around 80% of the maximum value, compared to only 26.6% in test 1, showing that subjects

improved most. The performance of realization of dynamics of human resource in project got 75% while its initial value is 19%. At the beginning, some of students draw the activities as X axis. Furthermore, the average performance on relating the schedule of project, which is calculated from the key path duration, increased from 25% to 82%. However, subjects performed not quit well relating time calculation in project with 50% at the beginning. Figure 4.22 illustrates the comparison of results between tests by criteria.
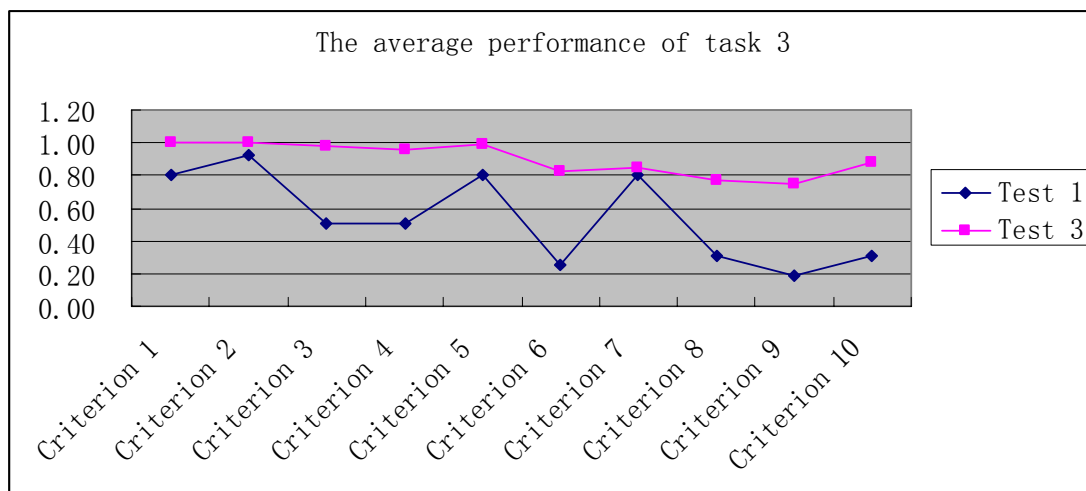
Figure 4.22 The comparison of performance between tests by criteria.

The analysis of the results indicates that the teaching session has had an influence on improving the performance of the subjects in the performance of labor curve question. The overall average performance increases after the teaching session from 47% to 86% of the full mark. Table 4.4 shows the average performances before and after the teaching (Test 1 and Test 3) by individual coding criteria and shows the absolute differences between them. Appendix F contains the raw data. Student-t statistics analysis is used to test whether the differences in performance are significant or not. According to these results, the teaching session leads to significant improvements in all the items.

Table 4.6 The Average performance of question 3 by coding individual criteria

	Test 1	Test 3	Difference	t Stat	P
Criterion 1	0.81	1.00	0.19	10. 33	0.00
Criterion 2	0.92	1.00	0.08	4. 28	0.00
Criterion 3	0.51	0.98	0.47	18. 54	0.00

Criterion 4	0.50	0.96	0.46	17. 79	0.00
Criterion 5	0.81	0.99	0.18	6. 51	0.00
Criterion 6	0.25	0.82	0.57	15. 43	0.00
Criterion 7	0.81	0.85	0.05	3. 23	0.00
Criterion 8	0. 30	0. 77	0.47	14. 87	0.00
Criterion 9	0. 19	0. 75	0.56	17. 92	0.00
Criterion 10	0. 31	0. 88	0.57	17. 96	0.00
Mean of all item	0.66	0.94	0.28		
St Dev	0.24	0.07	0.21		
N	217	217			

4.3.2. Levels of change in performance

1. Level of performance of Labor curve in test 1

There are only 5.5% of subjects performed the right answer at the beginning. Most of those who did part correct performed 30%-40%, and one fifth performed 0%-10%. About 66.4% subjects performed less than 50%。Figure 4.23 indicates distributed subjects in ranges of performance according to their initial average score. This implies They have a high potential for learning from the teaching session.
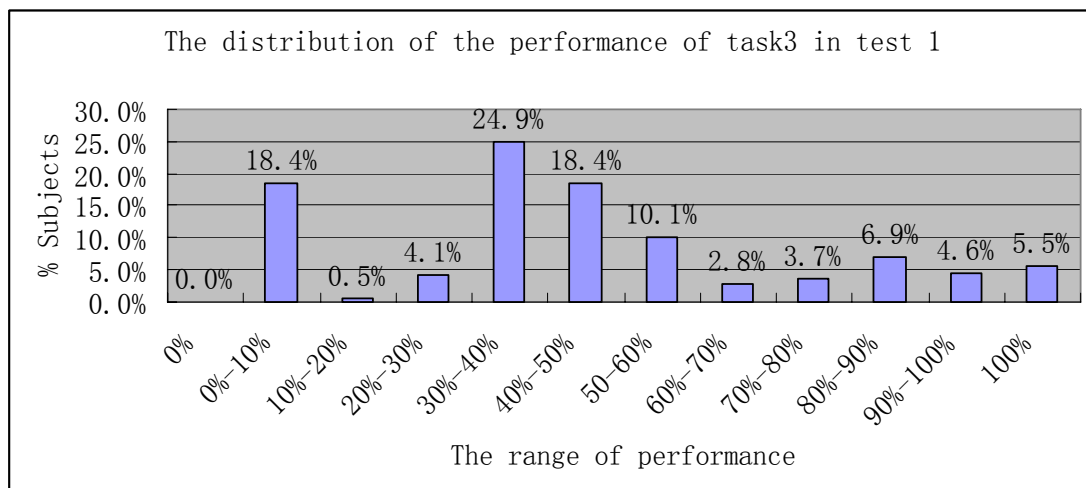
Figure 4.23 The distribution of performance of question3 in test 1

2. Levels of change in performance and Improvement Efficiency of performance.

For question 2, the pre-test is test 2 in the teaching experiment sequence, and the post-test is test 3. After the whole system dynamics teaching, they performed better than before. 12% of them got the full mark. When comparing individual average scores between test 1 and test 3, it is found that about 87.1% of the subjects improved

their performance and 12% did equal in both tests, while 0.9% of subjects (2 subjects) did worse. Here, Improvement Efficiency (IE in short) is also introduced. So, it is found that 12% of subjects enjoyed 100% Improvement Efficiency after teaching experience. The other 26.7% of subjects got their Improvement Efficiency ranging from 90% to 100% and 22.1% of subjects got their improvement efficiency 80%-90%。In whole, 67.7% of which got more than 50% Improvement Efficiency while 19.4 % subjects got less than 50% Improvement Efficiency. Figure 4.24. indicates distributed subjects in ranges of performance according to their Improvement Efficiency.
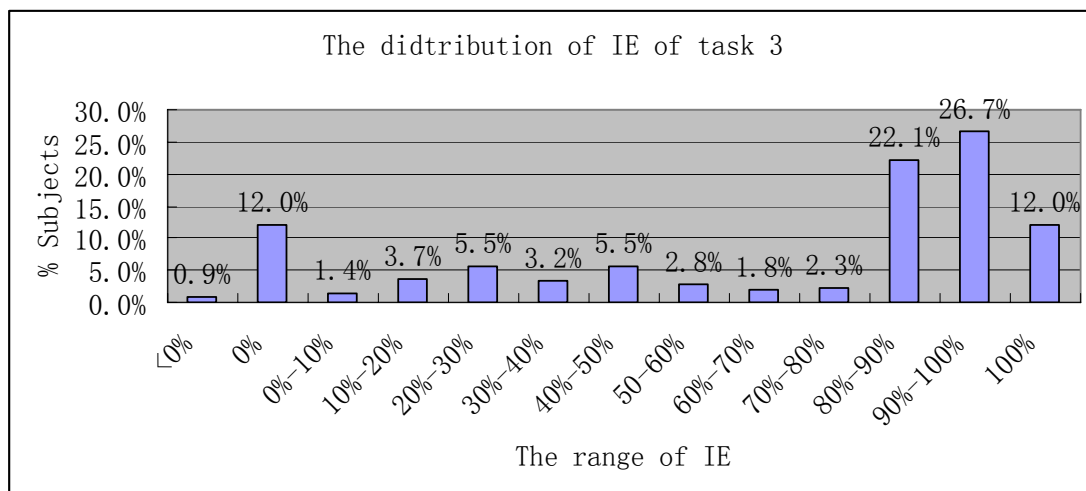
Figure 4.24 The distribution of IE of question 3

3. *Performance changes related their project management background.*

For there is no classroom to enclose 217 subjects, subjects are separated in two randomly. And subject need to use their project management knowledge to understand and draw Resource Gant Chart and labour curve. So, here we will compare their performance based on their performance in their project management test.

Table 4.7 The performance in *Bath Tub* question related with math bacground

	Improvement of question 1	Average Score of project management	Number
Goup 1	41.1%	77.5	115.0
Goup 2	37.4%	77.7	102.0

From table 4.7, we can find that average scores of math of these two groups are nearly same. The group1 got 41.1% improvement in question 1 while their average

score of project management is 77.5. Furthermore, the group 2 whose average score of project management is 77.7, got average 37.4% improvement of their performance in question3. Furthermore, ANOVA analysis suggested the P-value of these improvement of question 3 in groups is bigger than 0.05. It can be said that even they write the equations of the bath tub water but their performance of math have little influence on their work in question 3.

4.3.3. Levels of change in performance related system thinking training

Just as it is discussed in chapter 3, the hypothesis about subjects' performance of questions is related to project management directly. The question 3 is used to test whether system thinking ability got in SD-based training can help subjects understanding dynamics and complex in project management. That means we need to know whether subjects who got improvement in question 1 and question 2 can also got improvement in question 3 or not. From table 4.8, it is found that there are 175 subjects got improvement and 25 subjects did not in question 3 while they made progress in question 1. And there are 14 subjects increased their score and 3 subjects did not in question 3 while they did not make progress in question 1. The similar characters can be seen in the comparsion of results in question 2 and question3.   That is said person who got system thinking ablity with SD-based training can perform better when they face to peoject dynamics.

Table 4.8   The comparison of results in question 1 and question 3

Items		Improvement in Question 3	
		Y	N
Improvement in Question 1	Y	175	25
	N	14	3

Table 4.9   The comparison of results in question 2 and question 3

Items		Improvement in Question 3	
		Y	N
Improvement in Question 2	Y	186	28
	N	3	0

Chapter 5   Discussion

In this chapter, we first evaluate the effectiveness of a brief SD teaching session on facilitating learning on the dynamic development of resources over time that results from the accumulation of the net flows in Project Management. Then, we discuss the mental model about the failure to understand basic stock-and flow relationships and infer about the attendant behavior. Some issues regarding the experimental design, the teaching method, the test instruments and the method of assessment that may influence the process are presented next. Finally, we highlight some of the implications for teaching with SD and for project management.

5.1. Effectiveness of SD teaching in Project management

The results from the Bath Tub question and Schedule question suggest improvement in subjects' understanding of the dynamics of the stock-and-flow relationship after the SD teaching session. It may be inferred from the changes in average scores of the behavior described by subjects, when comparing the initial and final measures. Most subjects get a dynamic concept in the question 1 and question 2, even though many of them still fail to describe how the new flow defines the changes in the stock through accumulation. Subjects find it is easier to write the equations of question 1 and got the idea of dynamics. In contrast, it is hardest for them to draw trajectories of stock and understand qualitative and quantitative relate between the net flow and the changes in the stock. In other words, subjects are more easily enabled to get a dynamic mental model, but it is a bigger challenge to help them understand how behavior arises from the structure through accumulation of the net flow. This question is more challenging when describing the behavior of project work done. Only few of the subjects that draw correct project work done trajectories or similar ones become able to indicate how accumulation takes place over time at least qualitatively. Furthermore, results from labor curve question implicate that the subjects' dynamic and accumulation concepts about project management and skills of establishing benchmark of project management are improved after the teaching section with system dynamics in basics of Project Management.

5.1.1. Changes in performance

Comparisons between individual performance before and after the teaching session regarding the inferences about the behavior of Bath tub and Employees indicate that most subjects either improve or keep on performing as good as in the beginning. Indeed, the differences in performance on all the fundamental concepts to the stock-and-flow relationship are statistically significant after the teaching session. This implies that a noticeable proportion of the sample perceive a positive effect of the instruction that allows them to not only improve their score but also describe a more appropriate pattern of behavior of those resources. The improvement of Labor Curve performance indicates that subjects can transfer their understandings of system thinking to catch the dynamic behavior in project management.

The entire instruction makes most subjects change their inferences about the behavior of the stock over time, especially those who initially show a static mental model. According to the final description of Bath Tub and employees trajectories, most of the changes in the patterns of behavior suggest subjects get a dynamic mental model, even though some of them still make some mistakes in their analysis. Consequently, subjects whose final answer is "correct" or "partially correct" become the largest proportion of the sample in both cases. Besides, "lack of consistency" shows dynamics in both directions. Some subjects stop answering inconsistently whereas others start doing so during the session. In the correct answer, there are four stages. But in subjects' answer, there are six or eight stages which make un-consistency of curve and there is also negative value of stock in subjects' answer at the beginning. The largest fraction of subjects that show a discrete-event based thinking in the beginning gets a dynamic mental model that allows them to describe partially or completely correctly the behavior of Bath Tub or Employees. Indeed, this group is the greatest source of new partially and completely right responses. Additionally, the few subjects whose response suggest a combination of discrete event-based thinking and pattern matching are led to improve when inferring about Employees, getting dynamic mental models in most cases. However, some of them do not hold them until the end. However, most of them seem to keep static mental

models when inferring about the behavior of the stock. Almost half of the changes involve subjects who initially lack consistent pattern get a dynamic mental model but fail in the analysis. Moreover, most subjects whose initial prediction about Bath tub and Employees indicate dynamic mental models and some mistakes in the analysis show different or additional difficulties. However, those few subjects make the Project work done did not match the Production. Some of those who draw a correct Employees pattern become able to infer correctly or partially correctly about the Project work done trajectory.

Most of them initially show discrete event-based thinking in labor curve (bench mark of project cost and human resource management). They got right answer on the duration of the critical path but they draw the labor curve using activity as X axis. Moreover, the teaching session unleash the largest increases in inconsistent answers, which are mainly given by subjects who show static mental models in previous tests.

5.1.2. Changes in performance by concept

The nature of the effect of the instruction and each of its parts on the overall results is associated with three questions is similarly observed in the average performance of most categories on all concepts, in spite of the differences in the magnitude of the changes. Subjects perform best on the continuity of these resource trajectories after the first section, regardless of the initial pattern of thinking. Average performance on this concept increases sooner and faster than on the other concepts. The suggested improvement involves a large proportion of the total sample in first both questions. However, subjects who initially show "pattern matching" appear to be resistant to stop thinking discontinuously, even though most of them change their description of the behavior of the stock. Furthermore, the increase in performance on continuity is only meaningful when it takes place along with at least the achievement of a dynamic mental model, which makes subjects aware of the accumulation. Otherwise, drawing a continuous trajectory may be a result of copying this feature from the patterns observed in the instruction without any understanding of the real problem and coherency in the pattern of thinking.

The increase in awareness of accumulation is encouraged by the teaching section,

involving a great fraction of those who initially indicate discrete-event-based thinking. This part of the teaching session appear to be more effective on helping subjects with static mental models to get a dynamic one when they already take into consideration of the elements involved than otherwise. Subjects who initially answer inconsistently when inferring about the behavior of Employees find tougher to improve their performance on this matter than those who draw an inconsistent Bath tub trajectory. However, subjects who initially show static mental models appear to find this concept more difficult to improve. The effect of the instruction on improving this ability is modest, implying the slowest learning effect. Even most subjects who initially show a dynamic mental model, they fail to perform well in the question 3. This is also experienced by those who gain understanding of the other concepts during the instruction.

As subjects change their inferences about the behavior of Employees, they face a different behavioral question about the Project Work Done. Subjects who draw the right Employees trajectory face a linear input that leads the stock increase at changing rates. Only subjects who perform well when describing the development of Employees are enabled to infer about the behavior of the whole system. Some of those who get the correct Employees trajectory after the second section also improve their inference about Project work done. However, they still show problems in relating the net flow and the changes in the stock. This indicates that the initial way of thinking and the associated gap in understanding matters to the effectiveness of teaching, especially when the intervention is brief.

Subjects who draw right labor curve also did well in the question 2, which means that they can transfer basic concept of second system to the benchmark of project management. Correct inferences about the dynamic behavior of the human resources in question 3 require subjects to be aware of all flows that affect human resource and how they are connected (structure). Moreover, subjects need to understand how the changes in the human resource level are generated by the accumulation of the net flow over time (behavior). The underlying structure that relate resources and flows are taught during the first section.

5.2. Mental model

The patterns of behavior over time they predict when performing Bath Tub, Schedule questions and Project work done question suggest that people have difficulties in understanding the dynamics of basic stock-and-flow relationships. It is consistent with what has been found in experiments based on similar questions, which have been administered to similar or even more highly educated subjects (Sterman & Sweeney, 2002; Kainz and Ossimitz, 2002; Ossimitz, 2002; Sterman, 2002; Pala & Vennix, 2005).

In subjects' performance, it shows some problems in forming appropriate mental models of the stock-and flow relationships and making accurate inferences about the attendant behavior and suggests common features of mental models and heuristics. This fact allows us to set certain categories of typical patterns of thinking people seem to have when dealing with behavioral questions. One category refers to static mental models of the stock-and-flow relationships and analyses that do not capture the dynamics involved. Other category implies dynamic mental models. Such partially correct predictions suggest there is still a gap in subjects' grasp of the dynamics of stock-and-flow relationships. Similarly, Moxnes(1998) hypothesizes about subjects' mental models and the type of analysis they make. He argues that people tend to use simplified, inappropriate and static mental models and inefficient heuristics instead of proper dynamic models when facing complex problems. The discussion mainly focuses on subjects' inferences about the dynamic development of a stock that results from the simplest relationship with its own flows.

5.2.1. Static mental models

The patterns of thinking based on static mental models reflect traditional teaching approaches to the stock-and-flow relationship. Such approaches try to explain the behavior of a stock by correlating it with the variable that is thought of causing its change and defining mathematical relationships (Richmond, 2003; Moxnes, 2004; Sterman, 2005; Warren, 2005, 2002). However, a correlation relationship can not capture the real nature of the causality between variables when one of them is a stock. Thus, people have a poor understanding of the dynamics that arises from the

interaction among the variables and explains the way a stock behaves over time. Particularly, such failure affects people's grasp of dynamics embedded in the firms (Warren, 2002, 2005).

The most common approach to the behavioral questions about Bath Tub and Labor curve before the teaching session seems to be based on a static mental model. This model takes into account all the elements involved in the question 1 (Water in Bath Tub and in- and outflows) and connects them correctly. Subjects are aware of the net flow and its relationship with the water. However, they correlate both variables, taking the net flow as the independent one. Therefore, they ignore that the water changes gradually over time through accumulation of such a net flow even they write the equation of the question 1. In question 3, they assume changes in human resource only occur in the event of change in the net flow (new workers need in project depending on the question). Moxnes (1998) observes similar failures when studying the mismanagement of renewable resources. In the present study, the pattern of thinking, which is that persons can realize that some concepts are related but fail to understand the consequences of this relationship, is called discrete-event-based thinking. The reasoning is "the larger the difference between inflow and outflow, the more water". The reasoning behind discrete-event-based thinking has been mentioned by some authors in the SD community. Sterman (2000) states that people generally adopt an event–based view of causality, thinking of cause and effect as local and immediate. He highlights this is a principal deficiency in people's mental models. Furthermore, he suggests such an event-oriented worldview leads to an event-oriented approach to problem solving (Sterman,2000). In addition, other authors consider the tendency to focus on events as a constraint to deduce behavioral patterns intuitively (Richmond, 1993; Ossimitz, 2002).

Subjects from Sweeney and Sterman's experiment (2000) drew stock trajectories that seem to be discrete-event-based. They report this type of trajectory as typical error (11% of the answers) when subjects face the Cash Flow question or the Bathtub question with the same flow patterns. Sweeney and Sterman (2000) highlight the discontinuity in the stock trajectory, which jumps up and down in phase with the net

rate. They assumed subjects drew a stock trajectory whose shape matches the shape of the net rate. In addition, Sweneey and Sterman (2000) found another pattern of behavior that seem to be based on discrete simulation or what they call "spreadsheet thinking". This pattern assumes that changes occur suddenly between time periods. However, unlike discrete-event-based thinking, it recognizes the accumulation that takes place over time. Most of the answers in the present experiment suggest this reasoning. They got the right equation in question 1 but could not draw the right curve. It is difficult for them to use math analysis in question 2. The main reason is the background of these subjects. They are familiar to use math to analysis problem, but they failed to got main concept in their question 3 when they can not find any equation to help them.

Several subjects appear to have a static mental model of the resource-and-flow relationship that includes only one flow. Thus, they assume the resource is only affected by the inflow or the outflow. Other studies that have assessed people's understanding of the structure and dynamics of the global climate (Sterman & Sweeney, 2002; Moxnes & Saysel, 2004) and bioeconomics systems (Moxnes, 1998, 2000, 2004) have found this failure. According to them, subjects tend to identify evident inflows such as emissions and outflows such lichen grazing when predicting about the development of CO_2 in the atmosphere and the level of Lichen, respectively. However, they ignore associated flows such as absorption and growth. Sweeney and Sterman (2000) have seen this problem in the results from their bathtub experiment as well. Besides, this failure has also been seen in managerial contexts. Warren (1999) states that firm often worry about inflows, but give less attention to outflows. Most of the answers based on the described static and incomplete mental model suggest that subjects use a "pattern matching heuristic" to infer about dynamic behavior.

This heuristic matches the shape of the resource to the shape of the inflow. This is consistent with what other studies have found (Moxnes, 2000; Sweeney and Sterman, 2000; Sterman and Sweeney, 2002; Sterman, 2002; Moxnes & Saysel, 2004). Here, the category called "Pattern matching" refers to the pattern of thinking that results from using an incomplete static mental model of the resource-and-flow relationship

and a "pattern matching" heuristic. Pattern matching leads to erroneous inferences about the interactions between stocks and flows. Subjects correlate the stock and the inflow, taking the latter as independent variable. Hence, their reasoning seems to be: "The more inflow, the more water";"The more Hiring rate, the more Employees" ; "The more Production, the more Project work done". However, they forget about outflow and leaving, which make the stock level lower than it would be otherwise. Therefore, this pattern of thinking ignores important elements of the dynamics of stock-and-flow relationships: the outflow (and net flow) and the accumulation that takes place over time. For instance, they fail to grasp that Employees keeps constant when the hiring rate increases and becomes equal to the leaving rate at week 12. They find difficult to indicate that project work done increases while Production falls but still remains above the zero. Instead, subjects show the stock changing when and how the inflow pattern does. Both trajectories coincide on direction of change, shape and size of the change in most cases. However, some subjects make the behavior of the stock match the inflow pattern only qualitatively, showing numerical inaccuracies in the magnitude of the changes.

Likewise the others with static mental models, subjects ignore that the behavior of the stock reflects a process of accumulation of the net flow over time. Especially in question 3, they did not understand that the labor curve is accumulation of labor needed in every week. In this question, the labor needed every activity can calculate in every week for every activity occupies labor and time. Subjects can get labor every week by critical path analysis. Based on this, subjects got the inflow of labor accumulation. But most subjects could accumulate the labor needed every week.

5.2.2. Dynamic mental model

A dynamic mental model of the stock-and-flow relationship allows subjects to infer correctly about the development of the stock over time, based on a good grasp of the underlying structure. Subjects have in mind the main elements of the dynamics involved and connect them appropriately. They take into account both inflow and outflow and calculate the net flow accurately. Besides, they establish the correct causal relationship between the net flow and the stock, which captures the way these

elements interact over time. Subjects understand that the behavior of the stock results from the accumulation of the net flow over time. Furthermore, subjects relate quantitatively and qualitatively the net flow and the changes in the stock at any time and over each interval. This ability enables them to describe correctly the direction and the magnitude of the changes in the stock trajectory as well as its shape. Consequently, subjects make Bath tub increase non-linearly when the net flow change linearly and bigger than outflow, decrease crease non-linearly when the net flow linearly and less than outflow and keep them constant when the net flow is zero. Likewise, they describe parabolic project work done trajectories when the net flow changes linearly.

In spite of the potential of having a dynamic mental model for describing correctly the stock trajectory, some subjects have difficulties in doing so accurately. They are aware of both the underlying structure and the process of accumulation, but their grasp of how they determine the resource behavior over time is very poor. Subjects make the stock change when net flow is different from zero in the correct direction. However, they fail to describe how the net flow defines the slope of the stock trajectory at any time and, therefore, the magnitude of its changes. This failure is common to the ways of thinking described above, except the appropriate dynamic one. Other experiments based on the same sort of questions (Kainz and Ossimitz, 2002; Ossimitz, 2002; Sterman & Sweeney, 2002; Sterman, 2002; Pala & Vennix, 2005) have suggested such concepts are the hardest for people to grasp when describing dynamic behavior.

In practical terms, difficulties in relating the net flow and the changes in the resource level lead subjects to make two types of mistakes. Subjects are not able to draw the correct shape of the stock trajectory and/or fail to estimate accurately the changes in the stock level over an interval. Warren (2000b) argues that people rarely estimate numbers correctly when facing this sort of questions, even when they get the shape or the curve right. Similarly, Sterman (2002) questions whether the inability to do the arithmetic is an explanation for people's poor performance in this type of questions, alternative to the poor understanding of stocks and flows. In contrast,

Sweeney and Sterman (2000) stress the trivial character of the arithmetic required in their System Thinking Inventory questions. Hence, they think numerical errors mostly imply conceptual confusion. All subjects whose answer suggests a dynamic mental model and inappropriate analysis fail to relate the net flow and the slope of the resource at any time quantitatively. However, some of them indicate the awareness of the qualitative relationship. In contrast, other subjects show problems with the shape of the resource trajectory but estimate correctly the total change over each interval.

Generally, results suggest people have low levels of understanding of even the most basic concepts involved in the relationship between stock and flows. The results suggests that the most representative patterns of thinking people have before the instruction are those based on static mental models. Similarly, most subjects with dynamic mental models and appropriate analysis in the beginning appear to use them in questions. Furthermore, all subjects except one show problems drawing a project work done trajectory that accumulates even the assumed net flow.

5.3. Alternative explanations

The effectiveness of the instruction on facilitating the learning process of the dynamics of stock-and-flow relationships may be influenced by the experimental and teaching method designs, the test instruments and other procedures. In addition, the analyses of the results might be affected by the method of assessment used. This gives rises of the need for highlighting some particular features and limitations of such issues, which seem to be relevant.

5.3.1. Teaching method design

The experimental session asked subjects face repeatedly three questions based on problems with similar underlying structures to the ones under study, alternating between teaching and testing. On the one hand, subjects are expected to recognize the resemblance between such structures and use them when solving the questions' behavioral question. Nevertheless, even when teaching is recent, people do not necessarily use what they have learnt. It may take time for them to translate this new knowledge into the heuristic they firstly use when facing a question. Regarding the

awareness of analogical relationships, Doyle (1997) mentions the contrasting findings of experimental studies conducted in psychology. Here, the teaching method attempts to maximize the likelihood of transfer by teaching people about a generic basic system structure using the widespread bathtub analogy. Nersessian (1992) stated that analogies do inferential work and generate problem solution, besides being only guides to thinking. Doyle et al (1998) highlighted the potential influence of taking pre-test on increasing the effectiveness of the teaching session. They state that people get more aware of being studied and evaluated, which leads to make additional efforts. Here, such influences could be even stronger due to the number of tests performed.

5.3.2. Background of subjects

In the present experiment, the background of the participants should allow them to read and draw graphics. All of them are management science undergraduates at the third level and fourth level of the program. All have been taught math at least four semesters, respectively. Even though training and experience with mathematics may allow subjects to understand the way the information is delivery in the slide show, such knowledge is not necessarily translated into an intuitive appreciation of accumulations and stocks and flows (Sweeney and Sterman, 2000). Likewise, being taught in many other courses relative to Project Management does not appear to be effective on providing them with a good grasp of the project dynamic behavior. In question 1, they first try to write the equation of water not draw curve but they failed to write any equation when they faced to question 3 and they were lost. Subjects' prior knowledge also implies a challenge for the instruction. This knowledge has been influenced for several sources. Indeed, the results of the prior assessment through both Bath Tub and Labor curve suggest that subjects' perception of the underlying structures and their inferences of the attendant behavior reflect the approach and limitations of the traditional teaching in the field. Moreover, differences in subjects' academic background might matter to the influence of prior knowledge, whatever it is.

All Subjects had been enrolled in courses associated with Project Management. And none of them know anything about system dynamics. The information about

some courses subjects had attended previously suggests that all the subjects have had sort of contact with mathematics and management topics. Doing so would require evaluating the SD teaching strategies through which subjects have been taught and comparing them with this study's strategy. The importance of the focus on very simple stock-and-flow relationships for fostering people's grasp of dynamics has been highlighted just in recent years (Moxnes, 1998; Sterman, 2000; Sweeney and Sterman, 2000). Thus, an important issue for further analysis refers to compare and evaluate how this focus may matter to the effectiveness of other SD teaching on people's inferences about dynamic behavior.

5.3.3. Test instruments

The question 1 appears to be appropriate for testing subjects' understanding of the dynamics involved in a first-order stock-and-flow structure and linear net flow pattern. Furthermore, the higher level of complexity of the Schedule question constrains the analysis of the impact of the last phase on improving the description of the stock trajectory when the net flow is step pattern. The higher level of complexity of the Schedule question may lead subjects to perceptive differently the degree of difficulty of the question, even when describing Employees. It could make a difference between the first part of the Schedule question-Part I and the Bath Tub question, although the underlying relationships are similar. This is a possible explanation for one observation: performance in the Schedule question is slightly lower than in the other question.

There is not any stock and flow indication in question 3. But the base structure of this question is stock and flow system. Subjects have to use their project management knowledge to calculate the net flow of labor. Without awareness of dynamics and accumulation, they draw the labor curve with activity or without accumulation even they got right Resource Gantt Chart. This can be explanation for why some subjects only perform well in the end in the Labor curve question.

5.3.4. Method of assessment

The assessment of the understanding of the dynamics of a complex structure may require methodologies, which should focus on practical strategies for eliciting and mapping subjects' perceptions of the underlying structure that facilitate the

comparison between the prior and later versions. Here, the method of assessment used in the experiment seems to be suitable for capturing the evolving impact of the SD-based teaching session on subjects' sense of dynamic development over time. The set of criteria seems to be useful for providing relevant insight into this matter.

Criteria contribute to the analysis by providing a more precise measure of how much the change is, even though they make estimations according to average values. The overall estimation by subject assumes he gets the same in all criteria while the estimation by criterion assumes all subjects perform equally in each concept. It means criteria do not allow us perceive the nature of the individual changes in perception and prediction by themselves. Nevertheless, this limitation of the criteria is easily overcome with other procedures that benefit from the data available such as the definition of the levels of change in performance and the combined in both analysis of changes in average performance and improvement efficiency.

The set of criteria of question 3 is based on the concept of project management. It seems to be appropriate for the labor curve question due to the symmetry of the segments, assuming that subjects are aware of that. Though the differences between results calculated with each way are minor, the interpretation of them is different. This study's results indicate how well each subject performs, in average, on all the concepts in average, on each concept and overall. The other way reports the percentage of the criteria on which each subject perform well and the proportion of the sample that does so on each concept.

Chapter 6   Conclusion

The empirical studies presented in this thesis investigated the effect of System Dynamics based teaching to assist project management education. This study provides empirical evidence that people have problems in understanding the dynamics of the simplest stock-and-flow relationships that are found throughout the project. This is consistent with what has been found in previous experiments that have addressed this issue. And they improve their understanding of project complex after SD- based training. Moreover, this research found typical perceptions and assumptions about the dynamics under study that are repeatedly exhibited in subjects' inferences about the development of stock levels over time. According to this, the evolving impact of introducing gradually SD elements when teaching the dynamics involved on subjects' prior perceptions and inferences about this matter is analyzed. It has been found that subjects' prior approach to dynamic behavior matters to the effectiveness of an SD-based teaching session on facilitating learning about the dynamics of the resource-and-flow relationships and transfer their awareness of dynamics to project management while forgoing studies focused on the e-learning system with the

incorporated SD simulation model. People can get system thinking ability with SD-based teaching and this ability can help them improve their performance in the dynamics and accumulating behavior in project planning. The results are consistent with the hypothesis that PM decision-making can improve with SD-training. Moreover, our question is focus on project human resources planning, which is a part of whole project management. So performance on one task does not "prove" that hypothesis.

The present study suggests important insights regarding the usefulness of SD in project management education. However, it is still necessary to do more research in this field, given the few applications of SD in Project management teaching, and the great absence of assessment of the benefits that students really get from such approach. Especially for Chinese students who have very strong math background but

it is difficult for them to use their math knowledge to help them to solve the problem in the real world. Therefore, in this section important aspects are mentioned in order to improve in the future the outcome of this and coming experiments for those who may be interested in the field. Furthermore, study should be completed by replicating the experiment to gain better insight about its utility in project management in particular and in higher education in general. And teaching method & style are also considered in replicated teaching experiment to explore the question whether similar results would be obtained if the same experiment were conducted by other teachers or not. Especially for Chinese students with SD-based teaching in Chinese, it is wondered which caused performance to improve :the teacher's explanations or the SD tools that.

Here, we just focus on the dynamics and accumulation in project management. The feedback which is very common in this field is waiting for future experiment. Future work will be related to explore the feedback to our students. Experimental factors such as the duration of the experiments' sessions and the number of case studies approached with the SD teaching method seem to be relevant to enhance students' understanding of the dynamics and change. These need to be studied more details in the future. And the creation of generic tools that facilitate easy integration of SD models into e-learning systems is currently in the planning stage.

Reference

Abdel-Hamid, Tarek and Madnick, Stuart (1991) Software Project Dynamics, An Integrated Approach. Prentice-Hall. Englewood Cliffs, NJ.

Ding Shizhao, (2006) The overlook of chines project management, Project mamangement workshop, Tongji University, 2006, May, (in Chinese)

Doyle, J. (1997). The cognitive psychology of systems thinking. System Dynamics Review 13:253–265.

Doyles, J. and N. Ford (1998). Mental models concepts for System Dynamics research. System Dynamics Review 14: 3–29.

Doyle, J., M. Radzicki and W. Trees (1998). Measuring Change in Mental Models of Dynamic System: An Exploratory Study

Drappa, A., and Ludewig, J. (1999). Quantitative modeling for the interactive simulation of software projects. Journal of Systems and Software 46: 113–122.

Fisher, Deborah , Mietschin, Susan and Pollock Jr., David R. (1995) Benchmarking In Construction Industry. Journal of Management in Engineering. 11,1,50-55. Jan./Feb., 1995.

Ford, David N. (1995) The Dynamics of Project Management: An Investigation of the Impacts of Project Process and Coordination on Performance. Doctoral Thesis. Massachusetts Institute of Technology.

Ford, David N. (1997) Structuring Budget Contingency Management to Satisfy Multiple Development Objectives. A Report in Information Science. March, 1997.

Ford, David N. (1999) A Behavior Approach to Feedback Loop Dominance Analysis. System Dynamic Review. 15,1,3-36. Spring, 1999.

Ford, David N. and Sterman, John D. (1997) Dynamic Modeling of Product Development Process. System Dynamic Review. 14,1,31-68. Spring, 1998.

Forrester, Jay W. (1961) Industrial Dynamics. Productivity Press. Portland OR, USA.

Forrester, Jay. W. (1971). Counterintuitive behavior of social systems. Collected Papers of J.W. Forrester. Cambridge, MA: Wright-Allen Press. 89

Forrester, J. W. (1980). System Dynamics – Future opportunities. TIMS Studies in the Management Sciences 14: 7 – 21

Forrester, J. W. (1994). Learning through System Dynamics as Preparation for the 21st

Century. Keynote Address for Systems Thinking and Dynamic Modeling Conference for K-12 Education.

Forrester, Jay W. and Senge, Peter M. (1980) Tests for Building Confidence System Dynamics Model. TIMS Studies in the Management Sciences. 14,209-228, 1980.

Gentner, D., S. Brem, R. Ferguson, A. Markman, B. Levidow, P. Wolff and K. Forbus (1997). Analogical reasoning and conceptual change: A case study of Johannes Kepler. Journal of the Learning Sciences 6 (1): 3-40.

Goodman, Micheal R. (1988) Study Notes in System Dynamics. The MIT Press. Cambridge, MA. USA.

Hendrickson, Chris and Au, Tung (1989) Project Management for Construction. Prentice Hall. Englewood Cliffs, NJ, USA.
Harry L. Reif and Michel Mitri,(2005), How University Professors Teach Project Management for Information Systems, Communications of the ACM No. 8 August 2005/Vol. 48:14-135

Kainz, D and G. Ossimitz (2002). Can Students Learn Stock-Flow Thinking? : An Empirical Investigation, Proceedings of the 20th International Conference of the System Dynamics Society,

Kellner, M. I., and Hansen, G. A. January (1989). Software process modeling: A case study. Proc. 22nd Annual Hawaii Int. Conf. System Sciences.

J. Sterman, (1992) ''System dynamics modeling for project management.''Sloan School of Management, MIT, On-line Publication, <http://web.mit.edu/jsterman/www/>, 1992

Lane, D. C. (1995). On a resurgence of management simulation games. Journal of the Operational Research Society. 46: 604-625.

Lee S, Pena-Mora F, Park M, (2006) ,Web-enabled system dynamics model for error and change management on concurrent design and construction projects , Journal of computing in civil engineering 20 (4): 290-300 JUL-AUG 2006

Lee SH, Pena-Mora F, Park M, (2006) ,Dynamic planning and control methodology for strategic and operational construction project management ,Automation in construction 15 (1): 84-97 JAN 2006

Lin, C. Y. May (1993). Walking on battlefields: Tools for strategic software management. American
programmer: 33-40.

Lin, C. Y., Abdel-Hamid, T., and Sherif, J. S. (1997). Software-engineering process simulation model (SEPS). Journal of Systems and Software 38: 263-277.

Lipsey, M. (1990). Design Sensitivity. Sage Publications. Madachy,R., and Tarbet,D. June1999. Case studies in software process modeling with system dynamics. Proc. 2nd Software Process Simulation Modeling Workshop (ProSim 99). Silver Falls, Oregon.

Madachy, R., and Tarbet, D. June (1999). Case studies in software process modeling with system dynamics. Proc. 2nd Software Process Simulation Modeling Workshop (ProSim' 99). Silver Falls, Oregon.

Meredith, Jack R. and Mantel, Samuel J., JR. (1995) Project Management: A Managerial Approach. John Wiley&Sons, Inc. New York, Chichester, Brisbane, Toronto, Singapore.

Motawa IA (Motawa, I. A.), Anumba CJ (Anumba, C. J.), Lee S (Lee, S.), Pena-Mora F (Pena-Mora, F.), (2007) ,An integrated system for change management in construction, Automation in Construction 16 (3): 368-377 MAY 2007

Morecroft, J. D. W. (1988). System dynamics and microworlds for policymakers. European Journal of Operational Research 35: 301-320.

Moxnes E. (1998). Overexploitation of renewable resources: The role of misperceptions. Journal of Economic Behavior and Organization 37: 107-127.

Moxnes E. (2000). Not only the tragedy of the commons: misperceptions of feedback and policies for sustainable development. System Dynamics Review 16(4): 325–348.

Moxnes, E. (2004). Misperceptions basic dynamics, the case of renewable resource management. System Dynamics Review 20 (2): 139–162.

Moxnes, E. and A. Saysel (2004). Misperceptions of Global Climate Change: Information Policie. Climatic Change

Munch J, Pfahl D, Rus I, (2005) Virtual software engineering laboratories in support of trade-off analyses , Software Quality Journal 13 (4): 407-428 DEC 2005

Nersessian, N. (1992). How do scientists think? Capturing the dynamics of the Conceptual Change in Science. in R. Giere (Ed),Cognitive Models of Science, Minnesota Studies in the Philosophy of Science 15 (Minneapolis, University of Minnesota Press), pp. 3–44.

Ossimitz G. (2002). Stock-flow-thinking and reading stock-flow-related graphs: an empirical investigation in dynamic thinking abilities. Proceedings of the 20th International System Dynamics Conference, Palermo, July – August.

Pala, Ö. and J. Vennix (2005). Effect of system dynamics education on systems thinking inventory task performance. System Dynamics Review 21: 147–172.

Pfahl, D., Klemm, M., and Ruhe, G. (2001). A CBT module with integrated simulation component for software project management education and training. Journal of Software and Systems 59: 283-298.

Pfahl, D., Koval, N., and Ruhe, G. April (2001). An experiment for evaluating the effectiveness of using a system dynamics simulation model in software project management education. Proceedings of 7th International Software Metrics Symposium. London, United Kingdom, 97-109.

Pfahl D, Laitenberger O, Dorsch J, et al. (2003) An externally replicated experiment for evaluating the learning effectiveness of using simulations in software project management education   Empirical software engineering 8 (4): 367-395 DEC

Richmond, B. (1993): Systems thinking: critical thinking skills for the 1990s and beyond. In: System Dynamics Review 9 (2): 113-133.

 Rodriguez D (Rodriguez, Daniel), Sicilia MA (Sicilia, Miguel Angel), Cuadrado-Gallego JJ (Cuadrado-Gallego, Juan Jose), Pfahl D (Pfahl, Dietmar) , (2006), e-Learning in project management using simulation models: A case study based on the replication of an experiment IEEE transactions on education 49 (4): 451-463 NOV 2006

Rodrigues, Alexandre and Bowers, John. (1996) The Role of System Dynamics in Project Management. International Journal of Project Management. 14,4,213-220, August, 1996.

Smith, B. J., Nguyen, N., and Vidale, R. F. May (1993). Death of a software manager: How to avoid career suicide through dynamic software process modeling. American programmer 10–17.

Sterman, J. (1989). Misperceptions of Feedback in Dynamic Decision Making. Organizational Behavior and Human Decision Processes 43 (3): 301-335

Sterman, J. (1994). Learning in and about complex systems. System Dynamics Review 10: 291-330.

Sterman, J. (2000). Business dynamics: systems thinking and modeling for a complex world. McGraw-Hill Higher Education.

Sterman, J. (2002). All models are wrong: reflections on becoming a systems scientist. System Dynamics Review 18: 501–531.

Sterman, J. (2005). Learning from Evidence in a Complex World.

Sterman, J. and L. B. Sweeney (2002). Cloudy skies: Assessing public understanding of global warming. System Dynamics Review 18: 207–240.

Sweeney, L.B. and J. Sterman (2000). Bathtub Dynamics: Initial Results of a Systems Thinking Inventory. System Dynamics Review 16 (4): 249–286.

Warren, K. (2002). Competitive Strategy Dynamics. John Wiley & Sons.

Warren, K. (2005). Improving Strategic Management with the fundamental principles of System Dynamics.

Wheat, D. (2007). Do Stock-and-Flow feedback diagrams promote learning in Macroeconomics? *The Feedback Method. A System Dynamics Approach to Teaching Macroeconomics.* PhD Thesis, University of Bergen, Norway.

Williams, Gareth Vaughan(1995). Fast Track Pros and Cons: Considerations for Industrial Projects. Journal of Management in Engineering. 11,5,24-32. Sept./Oct., 1995.

Williams TM, (1999),Seeking optimum project duration extensions, Journa of the operational research society 50 (5): 460-467 MAY 1999

Appendix A: Bath Tub Question

Question 1:   Bath Tub Question (translation in English)

Consider the bathtub shown below. Water flows in at a certain rate, and exits through the drain at another:
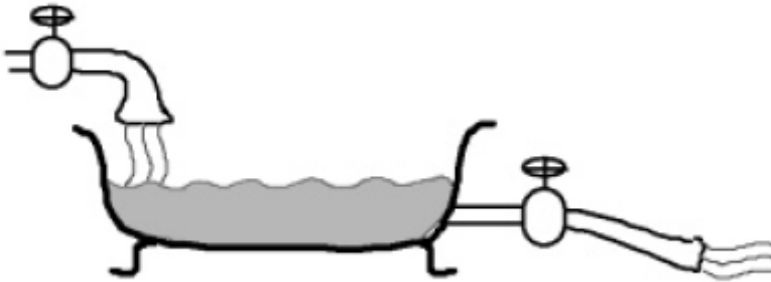
The graph below shows the hypothetical behaviour of the inflow and outflow rates for the bathtub. From that information, draw the behaviour of the quantity of water in the tub on the second graph below.

Assume the initial quantity in the tub(at time zero) is 100 liters.
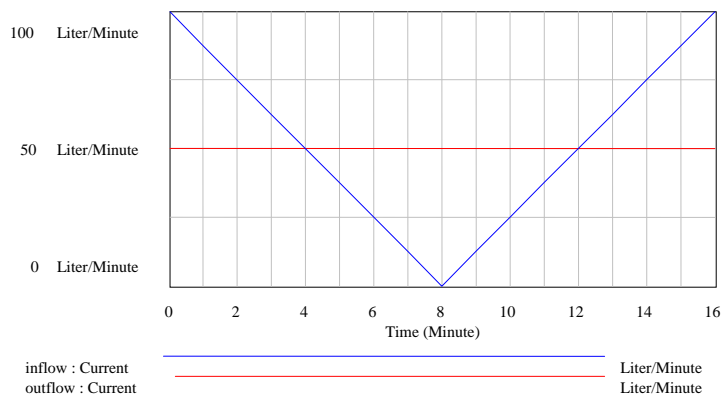
Appendix B: Schedule Question

Question 2:   Schedule Question (translation in English)

Consider a project team. It has initially 20 employees who work for project. The base structure see Figure.1. The hiring and leaving rates per week are different. The hypothetical behaviors of such rates are shown in Graph 1. The leaving rate could be assumed as constant and equal to 5 employees per week.
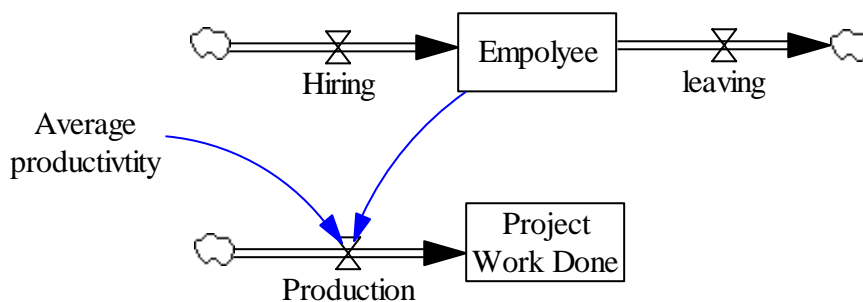
Historically, each employee has finished 1/400 of the project activity. The initial value of project work done is zero.
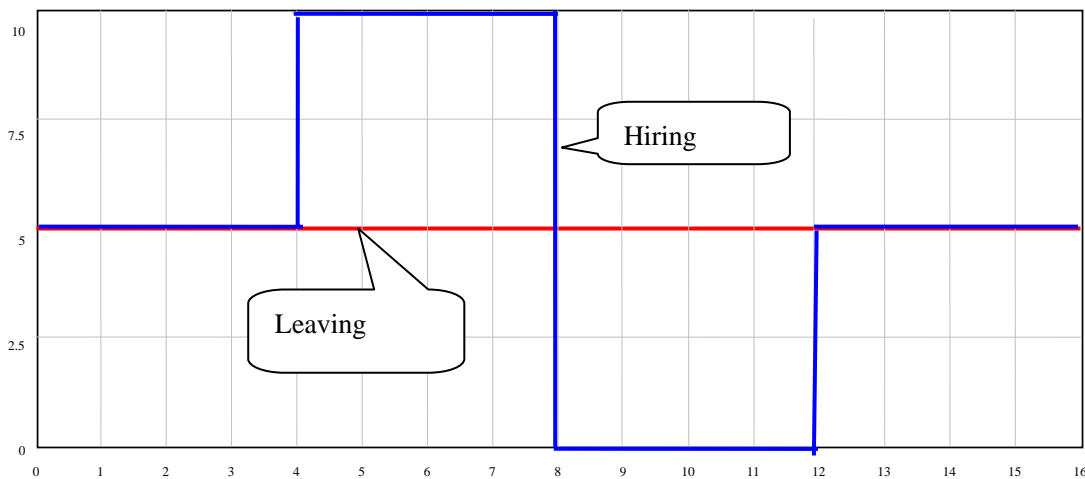
Appendix C: Labor Curve Question

Question 3: Labor Curve Question (translation in English)

Considering project X. After work break-down, the project manager finds that there are six activities. He sets the dependency and estimates the duration of every activity according to resource restrict. The characters of every activity I show in table.1. Would you like to help this manager to draw the Resource Gantt Chart and its labor curve (the Planed Value) .

Table 1 Characters of activities in project X

Activity	Start to Start	Finish to start	Labor occupied	Duration(weeks)
A	B		10	2
B	A		20	1
C		B	20	3
D		A	15	4
E		C	25	4
F		D	20	4

Appendix D: Instructional Content

Welcome to our class!

Lizhen Huang
Fuzhou University

1

- At beginning, You will perform Question 1_two tasks:
- Bath Tub Task
- Labor Curve Task

2

- Question 1
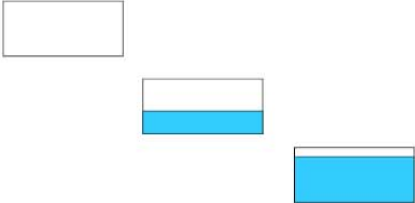
3

- There is a bath tub. As we know, it can keep the certain water.
- We call the quantity of water in Bath Tub " Level".
- And we use the rectangle to denote it

4

- The level of this Bath tub can be full, half , and any amount that is no more than full and no less than 0.

5

- We also call this level " stock"
- What can be stock？
Example:
Students in this classroom,
Cash in your bank account,
Employees in your project team,

6

As, we know that students in this classroom will change.
So, You may think what make the stock change.

?
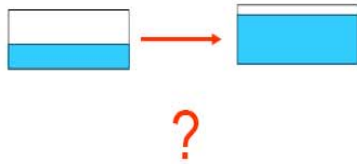
7

Think about the Bath Tub we show before. We can find that the level in Bath TUB change when water flow in , flow out or both.

8

We call the quantity of water that flows in the bath tub "INFLOW"
And we represent the "inflow" by a pipe flowing into the level(stock), which have a valve on it to control the flow.

Inflow → Water in Bath Tub
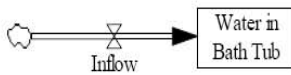
9

We call the quantity of water that flows out the bath tub "OUTFLOW"
And we represent the "outflow" by a pipe flowing out the level(stock), which have a valve on it to control the flow.

Water in Bath Tub → Outflow
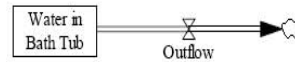
10

The whole presentation will be:

Inflow → Water in Bath Tub → Outflow
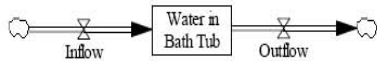
The quatity of flow can not see from the picture, but it can be measured during a period(minute, day,week,month, year,etc)

11

So, we get the general structure of stock and flows:

General Structure:

Inflow → Stock → Outflow

Key:

Stock

Flow

Valve (Flow Regulator)

Source or Sink
(Stocks outside model boundary)
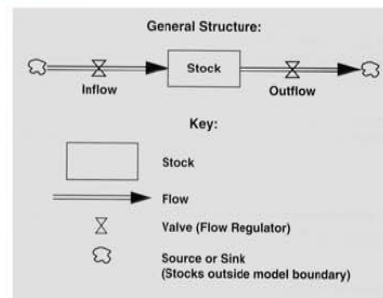
12

Example of Stock and flow
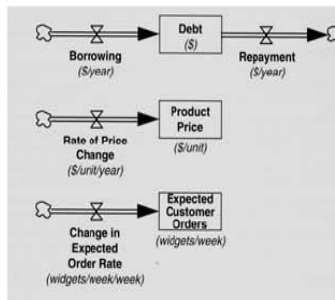
13

What is the relationship between stock and flow?

- The stock is accumulation of flow.
- Inflow makes the increase of stock.
- Outflow makes the decrease of stock.
- The stock can only change by its inflow and outflow.

14

- If inflow > outflow
- then Stock increases

- If inflow=outflow
- then Stock is equilibrium

- If inflow<outflow
- then stock decreases

15

So, we can got the equation:

Stock and Flow Diagram:
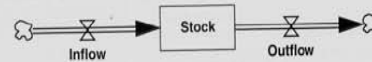
Integral Equation:

$$Stock(t) = \int_{t_0}^{t} [Inflow(s) - Outflow(s)]ds + Stock(t_0)$$

Differential Equation:

$$d(Stock)/dt = \text{Net Change in Stock} = Inflow(t) - Outflow(t)$$

16

And you may ask how to draw the change of level of water in bath tub over time.
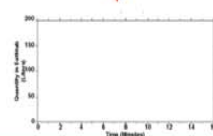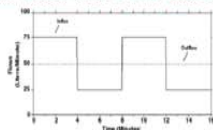
17

To do that, answer these Four simple question:

1. DIRECTION: Does the stock increase ,decrease or remain constant?
2. TOTAL CHANGE: How many liters of water are added or removed from the bathtub during the period?
3. SHAPE: How Does the level change? Linearly or Curve?
4. INITIAL VALUE：The Start point of your drawing.

18

After that, you may want know what can make the inflow and outflow change.

- Any Dependent variables which can cause flows change.

- That may be stock, other flows, auxiliary variables.

19
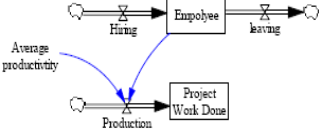
- We use "Causal link" to present the causal influences among the variables.

- The Symbol following, means "A" is the cause and "B" is the effect.

A   B

20

- Question 2

21
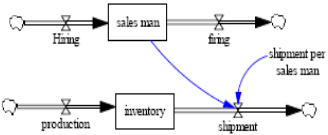
Second order system

- From task 2, you read two stocks, and one stock is the cause of other stock's flow. It is called Second order system.

22

Example of Second order system.

23

Go back to bath tub case.

- Consider that there is a kind of bacteria in the water.
- This bacteria can produce one kind substance.
- The number of bacteria in every liter water is constant.
- The productivity of bacteria is constant.
- The substance can release at a constant rate.

24

72

So,

Bacteria inside

PRODUCING

Substance

inflow — Water in bath tub — outflow

bacteria number per liter

productity of bacteria

the growth of substance — Substance — the release of substance

---
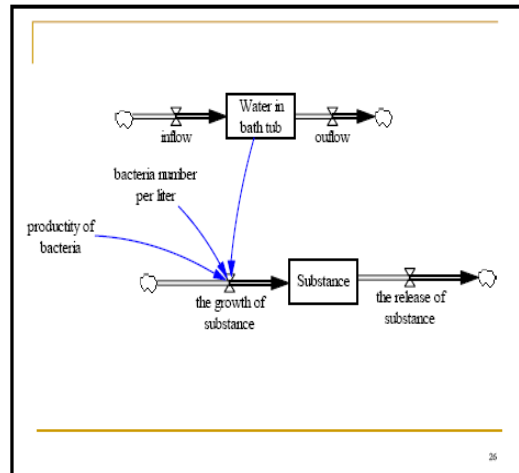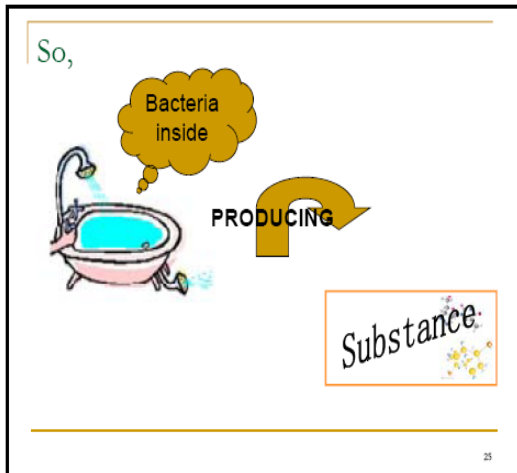
How to calculate the stock in this system?

- As we know, it is difficult to calculate high order system in Mathematics.

For the Bath tub:

- We can calculate the stock of water in bath tub firstly:

Then the number of bacteria

- =the number of bacteria per liter* water in Bath tub

Bacteria inside

And the growth of substance= the number of bacteria * productivity of bacteria

PRODUCING

At last, you can calculate the stock of substance

Substance

31

Just like project process:

- Employee
- Work done

Water in bath tub
inflow
outflow
bacteria number per liter
productity of bacteria
the growth of substance
Substance
the release of substance
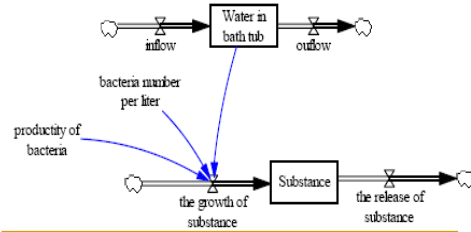
32

- Question 3

33

- Post Question

34

- Thanks for your attention!

35

Appendix E: Data of Subjects' Characters

Characters of subjects											
Student ID		Age		Gender		Major		Level		Proviouse knowledge of SD	
Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
070503102	070503528	20	21	1	1	1	1	3	3	0	0
070503106	070503539	20	21	1	1	1	2	3	3	0	0
070503109	070403141	20	20	1	1	2	1	3	3	0	0
070503111	070503107	20	20	0	1	1	1	3	3	0	0
070503116	070503110	20	23	0	1	1	1	3	4	0	0
070503119	070503112	20	20	0	0	1	1	3	3	0	0
070503123	070503113	20	20	0	0	1	1	3	3	0	0
070503127	070503114	20	23	0	0	2	2	3	4	0	0
070503130	070503115	20	20	0	1	2	2	3	3	0	0
070503131	070503117	21	20	0	1	2	2	3	3	0	0
070503132	070503121	20	23	0	1	1	2	3	4	0	0
070503138	070503124	20	21	0	0	3	3	3	3	0	0
070503144	070503125	20	20	1	0	3	3	3	3	0	0
070503228	070503126	21	22	1	0	2	2	3	3	0	0
070503236	070503129	21	22	1	0	3	3	3	3	0	0
070503238	070503133	21	21	0	0	3	3	3	3	0	0
070503239	070503134	21	21	1	1	3	3	3	3	0	0
070503242	070503135	21	21	1	1	3	3	3	3	0	0

070503243	070503136	21	21	0	0	3	3	3	3	0	0
070503244	070503137	21	21	1	1	3	3	3	3	0	0
070503246	070503139	21	21	1	1	3	2	3	3	0	0
070503304	070503140	21	21	1	1	3	2	3	3	0	0
070503306	070503142	21	21	1	1	2	2	3	3	0	0
070503312	070503143	21	21	1	1	1	1	3	3	0	0
070503314	070503201	21	21	1	1	1	1	3	3	0	0
070503321	070503202	22	21	1	1	2	2	3	3	0	0
070503322	070503204	21	22	0	0	2	2	3	3	0	0
070503323	070503207	21	22	0	0	2	2	3	3	0	0
070503325	070503213	21	22	1	1	2	2	3	3	0	0
070503334	070503214	21	22	1	1	3	3	3	3	0	0
070503339	070503216	21	22	1	1	1	1	3	3	0	0
070503340	070503217	22	22	1	1	2	2	4	3	0	0
070503344	070503220	21	23	1	1	2	2	3	4	0	0
070503402	070503221	21	21	1	1	2	2	3	3	0	0
070503407	070503223	22	21	1	1	3	3	4	3	0	0
070503409	070503226	21	21	1	1	3	3	3	3	0	0
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070503424	070503234	22	23	0	0	1	1	4	4	0	0
070503425	070503240	22	22	1	1	1	1	3	3	0	0
070503430	070503243	23	21	1	1	1	1	4	3	0	0

070503432	070503245	23	21	1	1	2	2	4	3	0	0
070503502	070503246	23	21	1	1	3	3	4	3	0	0
070503503	070503303	23	22	0	0	3	3	4	3	0	0
070503505	070503307	22	22	0	0	1	1	4	3	0	0
070503506	070503309	21	22	1	1	1	1	4	3	0	0
070503507	070503310	22	22	1	1	1	1	3	3	0	0
070503508	070503311	22	22	1	1	2	2	3	3	0	0
070503509	070503313	22	21	1	1	3	3	3	3	0	0
070503511	070503315	22	21	1	1	3	3	4	3	0	0
070503512	070503316	22	21	0	0	1	1	3	3	0	0
070503514	070503318	22	21	1	1	1	1	4	3	0	0
070503515	070503319	22	21	0	0	1	1	3	3	0	0
070503517	070503320	22	21	1	1	2	2	3	3	0	0
070503523	070503324	22	22	0	0	3	3	3	3	0	0
070503526	070503326	22	22	1	1	3	3	3	3	0	0
070503527	070503327	22	21	1	1	2	2	3	3	0	0
070503530	070503328	22	21	1	1	2	2	3	3	0	0
070503531	070503329	22	22	1	1	2	1	3	4	0	0
070503532	070503332	22	22	1	1	3	3	3	4	0	0
070503533	070503333	22	22	1	1	3	3	3	4	0	0
070503538	070503335	22	22	1	1	3	3	3	4	0	0
070503540	070503336	22	22	1	1	2	2	3	4	0	0
070503543	070503341	23	23	1	1	2	2	4	4	0	0
070503544	070503343	21	21	1	1	1	1	3	4	0	0
070503101	070503344	21	21	0	0	2	2	3	4	0	0

070503103	070503345	22	21	1	1	3	3	3	3	0	0
070503105	070503346	21	21	1	1	3	3	3	3	0	0
070503108	070503410	21	21	1	1	2	2	3	3	0	0
070503109	070503415	21	21	1	1	2	2	3	3	0	0
070503120	070503426	21	21	1	1	2	2	3	4	0	0
070503122	070503428	21	21	1	1	2	2	3	3	0	0
070503128	070503431	22	21	1	1	2	2	3	3	0	0
070503141	070503439	22	21	1	1	2	2	3	3	0	0
070503145	070503440	22	22	0	0	2	2	3	3	0	0
070503146	070503442	22	22	1	1	2	2	3	3	0	0
070503203	070503443	22	22	0	0	2	2	3	3	0	0
070503205	070503444	21	21	0	0	2	2	3	3	0	0
070503209	070503445	22	22	1	1	2	2	3	4	0	0
070503210	070503501	22	21	0	0	1	1	3	3	0	0
070503215	070503510	22	22	0	0	2	2	3	3	0	0
070503219	070503513	22	21	1	1	3	3	3	4	0	0
070503222	070503518	22	21	1	1	3	3	3	3	0	0
070503224	070503519	22	21	1	1	2	2	3	3	0	0
070503225	070503520	21	21	1	1	2	2	3	3	0	0
070503235	070503522	22	21	1	1	1	1	3	3	0	0
070503237	070503524	22	21	1	1	2	2	3	3	0	0
070503301	070503529	21	21	1	1	3	3	3	3	0	0
070503302	070503532	21	22	1	1	3	3	3	3	0	0
070503305	070503533	21	21	0	0	3	3	3	3	0	0
070503308	070503534	21	21	1	1	2	3	3	3	0	0

070503317	070503536	21	21	1	1	3	3	3	3	0	0
070503330	070503538	21	21	1	1	2	3	3	4	0	0
070503337	070503542	22	21	1	1	3	3	3	3	0	0
070503403	070503545	21	21	1	1	3	3	3	3	0	0
070503406	070402545	21	21	1	1	3	3	3	3	0	0
070503413	070402530	21	21	1	1	3	3	3	3	0	0
070503414	070402613	22	21	1	1	3	3	3	3	0	0
070503416	070402636	21	21	1	0	3	3	3	3	0	0
070503418	070501402	21	21	1	0	3	3	3	3	0	0
070503433	070502108	21	21	0	0	3	3	3	3	0	0
070503434	070502114	21	21	0	0	2	2	3	3	0	0
070503435	070502117	21	21	0	0	3	3	3	3	0	0
070503436	070502126	21	21	0	1	3	3	3	3	0	0
070503438	070502133	21	21	0	1	2	2	3	3	0	0
070503504		21		0		2		3		0	
070503516		21		0		1		3		0	
070503521		21		1		2		3		0	

Characteristics	P-value[2]
Age	0.62916
Gender	0.6385
Major	0.9604
Level	0.3875

[2] Number of group1 is 110,Number of group 2 is 107.

Appendix F: Data of Question 1 Performance

	Subjects score of Question 1 in test 1											
Items	**Direction of change**			Shape				Total Change	Initial Value	Total Score	correct pecentage	Full MARK
	increase or decrease	Accumulation: Maximum and minimum	Total of part 1	Continuity	Linear growth or Non-linear growth	Net flow = stock's slope	Total of part 2					
Student ID	Criterion 1	Criterion 2		Criterion 3	Criterion 4	Criterion 5		Criterion 6	Criterion 7			
070503102	0	0	0	8	8	0	16	0	2	18	39	46
070503106	0	0	0	2	8	0	10	0	2	12	26	46
070503109	4	4	8	8	0	4	12	8	2	30	65	46
070503111	0	0	0	2	2	0	4	0	2	6	13	46
070503116	8	4	12	8	8	8	24	0	0	36	78	46
070503119	8	4	12	8	8	8	24	0	2	38	83	46
070503123	8	4	12	0	8	0	8	8	0	28	61	46
070503127	8	4	12	0	8	4	12	6	2	32	70	46
070503130	8	4	12	0	8	0	8	8	0	28	61	46
070503131	8	4	12	0	8	4	12	6	2	32	70	46
070503132	0	0	0	2	2	0	4	0	2	6	13	46
070503138	8	4	12	0	8	4	12	6	2	32	70	46
070503144	8	4	12	0	8	0	8	8	0	28	61	46
070503228	0	0	0	2	2	0	4	0	2	6	13	46
070503236	8	4	12	8	8	8	24	0	0	36	78	46

070503238	0	0	0	8	8	0	16	0	2	18	39	46
070503239	0	0	0	2	8	0	10	0	2	12	26	46
070503242	4	4	8	8	0	4	12	8	2	30	65	46
070503243	0	0	0	2	2	0	4	0	2	6	13	46
070503244	8	4	12	8	8	8	24	0	0	36	78	46
070503246	8	4	12	8	8	8	24	0	0	36	78	46
070503304	0	0	0	8	8	0	16	0	2	18	39	46
070503306	0	0	0	2	8	0	10	0	2	12	26	46
070503312	4	4	8	8	0	4	12	8	2	30	65	46
070503314	0	0	0	2	2	0	4	0	2	6	13	46
070503321	8	4	12	8	8	8	24	0	0	36	78	46
070503322	0	0	0	2	8	0	10	0	2	12	26	46
070503323	4	4	8	8	0	4	12	8	2	30	65	46
070503325	0	0	0	2	2	0	4	0	2	6	13	46
070503334	8	4	12	0	8	0	8	8	0	28	61	46
070503339	8	4	12	0	8	4	12	6	2	32	70	46
070503340	0	0	0	2	2	0	4	0	2	6	13	46
070503344	8	4	12	0	8	4	12	6	2	32	70	46
070503402	8	4	12	0	8	0	8	8	0	28	61	46
070503407	0	0	0	2	2	0	4	0	2	6	13	46
070503409	8	4	12	8	8	8	24	0	0	36	78	46
070503411	0	0	0	8	8	0	16	0	2	18	39	46
070503417	0	0	0	2	8	0	10	0	2	12	26	46
070503420	4	4	8	8	0	4	12	8	2	30	65	46
070503421	0	0	0	2	2	0	4	0	2	6	13	46

070503424	8	4	12	8	8	8	24	0	0	36	78	46
070503425	0	0	0	2	8	0	10	0	2	12	26	46
070503430	4	4	8	8	0	4	12	8	2	30	65	46
070503432	0	0	0	2	2	0	4	0	2	6	13	46
070503502	8	4	12	8	8	8	24	0	0	36	78	46
070503503	4	4	8	0	8	0	8	4	0	20	43	46
070503505	8	4	12	0	8	4	12	6	2	32	70	46
070503506	0	0	0	2	2	0	4	0	2	6	13	46
070503507	8	4	12	0	8	4	12	6	2	32	70	46
070503508	8	4	12	0	8	0	8	8	0	28	61	46
070503509	0	0	0	2	2	0	4	0	2	6	13	46
070503511	8	4	12	8	8	8	24	0	0	36	78	46
070503512	0	0	0	8	8	0	16	0	2	18	39	46
070503514	0	0	0	2	8	0	10	0	2	12	26	46
070503515	4	4	8	8	0	4	12	8	2	30	65	46
070503517	0	0	0	2	2	0	4	0	2	6	13	46
070503523	4	4	8	0	8	0	8	4	2	22	48	46
070503526	0	0	0	8	8	0	16	0	2	18	39	46
070503527	0	0	0	2	8	0	10	0	2	12	26	46
070503530	4	4	8	8	0	4	12	8	2	30	65	46
070503531	0	0	0	2	2	0	4	0	2	6	13	46
070503532	4	4	8	8	0	4	12	8	2	30	65	46
070503533	4	4	8	0	8	0	8	4	2	22	48	46
070503538	4	4	8	0	8	0	8	4	2	22	48	46
070503540	4	4	8	0	8	0	8	4	2	22	48	46

070503543	4	4	8	0	8	0	8	4	2	22	48	46
070503544	4	4	8	0	8	0	8	4	2	22	48	46
070503101	8	4	12	8	8	8	24	0	0	36	78	46
070503103	8	4	12	8	8	8	24	0	0	36	78	46
070503105	8	4	12	8	8	8	24	8	0	44	96	46
070503108	8	4	12	8	8	8	24	8	0	44	96	46
070503109	8	4	12	8	8	8	24	8	2	46	100	46
070503120	8	4	12	8	8	8	24	0	0	36	78	46
070503122	0	0	0	8	8	0	16	0	2	18	39	46
070503128	0	0	0	2	8	0	10	0	2	12	26	46
070503141	4	4	8	8	0	4	12	8	2	30	65	46
070503145	0	0	0	2	2	0	4	0	2	6	13	46
070503146	8	4	12	8	8	8	24	0	0	36	78	46
070503203	8	4	12	8	8	8	24	0	0	36	78	46
070503205	0	0	0	2	8	0	10	0	2	12	26	46
070503209	4	4	8	8	0	4	12	8	2	30	65	46
070503210	0	0	0	2	2	0	4	0	2	6	13	46
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070503219	8	4	12	0	8	4	12	6	2	32	70	46
070503222	8	4	12	8	8	8	24	0	0	36	78	46
070503224	8	4	12	8	8	8	24	0	0	36	78	46
070503225	8	4	12	8	8	8	24	8	0	44	96	46
070503235	8	4	12	8	8	8	24	8	0	44	96	46
070503237	8	4	12	8	8	8	24	8	2	46	100	46
070503301	0	0	0	8	8	0	16	0	2	18	39	46

070503302	0	0	0	2	8	0	10	0	2	12	26	46
070503305	4	4	8	8	0	4	12	8	2	30	65	46
070503308	0	0	0	2	2	0	4	0	2	6	13	46
070503317	8	4	12	8	8	8	24	0	0	36	78	46
070503330	8	4	12	8	8	8	24	0	0	36	78	46
070503337	8	4	12	8	8	8	24	0	0	36	78	46
070503403	8	4	12	8	8	8	24	0	0	36	78	46
070503406	8	4	12	8	8	8	24	0	0	36	78	46
070503413	4	4	8	0	8	0	8	4	0	20	43	46
070503414	8	4	12	0	8	4	12	6	2	32	70	46
070503416	8	4	12	8	8	8	24	0	0	36	78	46
070503418	8	4	12	8	8	8	24	0	0	36	78	46
070503433	8	4	12	8	8	8	24	8	0	44	96	46
070503434	8	4	12	8	8	8	24	8	0	44	96	46
070503435	8	4	12	8	8	8	24	8	2	46	100	46
070503436	8	4	12	8	8	8	24	8	0	44	96	46
070503438	8	4	12	8	8	8	24	8	0	44	96	46
070503504	8	4	12	8	8	8	24	8	2	46	100	46
070503516	0	0	0	8	8	0	16	0	2	18	39	46
070503521	0	0	0	2	8	0	10	0	2	12	26	46
070503528	4	4	8	8	0	4	12	8	2	30	65	46
070503539	0	0	0	2	2	0	4	0	2	6	13	46
070403141	8	4	12	8	8	8	24	0	0	36	78	46
070503107	8	4	12	8	8	8	24	0	0	36	78	46
070503110	8	4	12	8	8	8	24	8	0	44	96	46

070503112	8	4	12	8	8	8	24	8	0	44	96	46
070503113	8	4	12	8	8	8	24	8	2	46	100	46
070503114	8	4	12	8	8	8	24	8	0	44	96	46
070503115	8	4	12	8	8	8	24	8	0	44	96	46
070503117	8	4	12	8	8	8	24	8	2	46	100	46
070503121	0	0	0	8	8	0	16	0	2	18	39	46
070503124	0	0	0	2	8	0	10	0	2	12	26	46
070503125	4	4	8	8	0	4	12	8	2	30	65	46
070503126	0	0	0	2	2	0	4	0	2	6	13	46
070503129	0	0	0	2	8	0	10	0	2	12	26	46
070503133	4	4	8	8	0	4	12	8	2	30	65	46
070503134	0	0	0	2	2	0	4	0	2	6	13	46
070503135	8	4	12	8	8	8	24	0	0	36	78	46
070503136	8	4	12	8	8	8	24	0	2	38	83	46
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070503139	8	4	12	0	8	4	12	6	2	32	70	46
070503140	8	4	12	0	8	0	8	8	0	28	61	46
070503142	8	4	12	0	8	4	12	6	2	32	70	46
070503143	0	0	0	2	2	0	4	0	2	6	13	46
070503201	0	0	0	2	2	0	4	0	2	6	13	46
070503202	8	4	12	8	8	8	24	0	0	36	78	46
070503204	8	4	12	8	8	8	24	0	2	38	83	46
070503207	8	4	12	0	8	0	8	8	0	28	61	46
070503213	8	4	12	0	8	4	12	6	2	32	70	46
070503214	8	4	12	0	8	0	8	8	0	28	61	46

070503216	8	4	12	0	8	4	12	6	2	32	70	46
070503217	0	0	0	2	2	0	4	0	2	6	13	46
070503220	8	4	12	0	8	4	12	6	2	32	70	46
070503221	8	4	12	0	8	0	8	8	0	28	61	46
070503223	0	0	0	2	2	0	4	0	2	6	13	46
070503226	8	4	12	8	8	8	24	0	0	36	78	46
070503227	0	0	0	8	8	0	16	0	2	18	39	46
070503229	0	0	0	2	8	0	10	0	2	12	26	46
070503230	4	4	8	8	0	4	12	8	2	30	65	46
070503232	0	0	0	2	2	0	4	0	2	6	13	46
070503234	8	4	12	8	8	8	24	0	0	36	78	46
070503240	8	4	12	8	8	8	24	0	0	36	78	46
070503243	0	0	0	8	8	0	16	0	2	18	39	46
070503245	0	0	0	2	8	0	10	0	2	12	26	46
070503246	4	4	8	8	0	4	12	8	2	30	65	46
070503303	0	0	0	2	2	0	4	0	2	6	13	46
070503307	8	4	12	8	8	8	24	0	0	36	78	46
070503309	0	0	0	2	2	0	4	0	2	6	13	46
070503310	0	0	0	2	8	0	10	0	2	12	26	46
070503311	4	4	8	8	0	4	12	8	2	30	65	46
070503313	0	0	0	2	2	0	4	0	2	6	13	46
070503315	8	4	12	8	8	8	24	0	0	36	78	46
070503316	8	4	12	8	8	8	24	0	2	38	83	46
070503318	8	4	12	0	8	0	8	8	0	28	61	46
070503319	8	4	12	0	8	4	12	6	2	32	70	46

070503320	8	4	12	0	8	0	8	8	0	28	61	46
070503324	8	4	12	0	8	4	12	6	2	32	70	46
070503326	0	0	0	2	2	0	4	0	2	6	13	46
070503327	0	0	0	2	2	0	4	0	2	6	13	46
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070503329	8	4	12	8	8	8	24	0	2	38	83	46
070503332	8	4	12	0	8	0	8	8	0	28	61	46
070503333	8	4	12	0	8	4	12	6	2	32	70	46
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070503336	8	4	12	0	8	4	12	6	2	32	70	46
070503341	0	0	0	2	2	0	4	0	2	6	13	46
070503343	8	4	12	0	8	4	12	6	2	32	70	46
070503344	8	4	12	0	8	0	8	8	0	28	61	46
070503345	0	0	0	2	2	0	4	0	2	6	13	46
070503346	8	4	12	8	8	8	24	0	0	36	78	46
070503410	0	0	0	8	8	0	16	0	2	18	39	46
070503415	0	0	0	2	8	0	10	0	2	12	26	46
070503426	4	4	8	8	0	4	12	8	2	30	65	46
070503428	0	0	0	2	2	0	4	0	2	6	13	46
070503431	4	4	8	8	0	4	12	8	2	30	65	46
070503439	0	0	0	2	2	0	4	0	2	6	13	46
070503440	8	4	12	8	8	8	24	0	0	36	78	46
070503442	8	4	12	8	8	8	24	0	2	38	83	46
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070503444	8	4	12	0	8	4	12	6	2	32	70	46

070503445	8	4	12	0	8	0	8	8	0	28	61	46
070503501	8	4	12	0	8	4	12	6	2	32	70	46
070503510	0	0	0	2	2	0	4	0	2	6	13	46
070503513	0	0	0	2	2	0	4	0	2	6	13	46
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070503519	8	4	12	8	8	8	24	0	2	38	83	46
070503520	8	4	12	0	8	0	8	8	0	28	61	46
070503522	8	4	12	0	8	4	12	6	2	32	70	46
070503524	8	4	12	0	8	0	8	8	0	28	61	46
070503529	8	4	12	0	8	4	12	6	2	32	70	46
070503532	0	0	0	2	2	0	4	0	2	6	13	46
070503533	8	4	12	0	8	4	12	6	2	32	70	46
070503534	8	4	12	0	8	0	8	8	0	28	61	46
070503536	0	0	0	2	2	0	4	0	2	6	13	46
070503538	8	4	12	8	8	8	24	0	0	36	78	46
070503542	0	0	0	8	8	0	16	0	2	18	39	46
070503545	0	0	0	2	8	0	10	0	2	12	26	46
070402545	4	4	8	8	0	4	12	8	2	30	65	46
070402530	0	0	0	2	2	0	4	0	2	6	13	46
070402613	8	4	12	8	8	8	24	0	0	36	78	46
070402636	0	0	0	2	2	0	4	0	2	6	13	46
070501402	8	4	12	8	8	8	24	0	0	36	78	46
070502108	0	0	0	8	8	0	16	0	2	18	39	46
070502114	0	0	0	2	8	0	10	0	2	12	26	46
070502117	4	4	8	8	0	4	12	8	2	30	65	46

070502126	0	0	0	2	2	0	4	0	2	6	13	46
070502133	8	4	12	8	8	8	24	0	0	36	78	46
Average score	4.626728	2.599078	7.225806	4.322581	6.0553	3.24424	13.62212	3.078341	1.299539	25.22581	54.83871	46

Subjects score of Question 1 in test 2												
	Direction of change			Shape								
Items	increase or decrease	Accumulation: Maximum and minimum	Total of part 1	Continuity	Linear growth or Non-linear growth	Net flow = stock's slope	Total of part 2	Total Change	Initial Value	Total Score	correct pecentage	Full MARK
Student ID	Criterion 1	Criterion 2		Criterion 3	Criterion 4	Criterion 5		Criterion 6	Criterion 7			
070503102	8	4	12	8	8	8	24	8	2	46	100	46
070503106	8	4	12	8	8	8	24	8	2	46	100	46
070503109	4	4	8	8	8	4	20	8	2	38	83	46
070503111	8	4	12	8	8	8	24	0	2	38	83	46
070503116	8	4	12	8	8	8	24	0	2	38	83	46
070503119	8	4	12	8	8	8	24	0	2	38	83	46
070503123	8	4	12	0	8	0	8	8	2	30	65	46
070503127	8	4	12	8	8	8	24	0	2	38	83	46
070503130	8	4	12	8	8	8	24	0	2	38	83	46
070503131	8	4	12	8	8	8	24	0	2	38	83	46
070503132	8	4	12	8	8	8	24	0	2	38	83	46
070503138	8	4	12	0	8	0	8	8	0	28	61	46

070503144	8	4	12	8	8	8	24	0	0	36	78	46
070503228	8	4	12	0	8	0	8	8	0	28	61	46
070503236	8	4	12	8	8	8	24	0	0	36	78	46
070503238	8	4	12	8	8	8	24	8	2	46	100	46
070503239	8	4	12	8	8	8	24	8	2	46	100	46
070503242	8	4	12	8	8	8	24	8	2	46	100	46
070503243	4	4	8	8	8	4	20	8	2	38	83	46
070503244	8	4	12	8	8	8	24	0	2	38	83	46
070503246	8	4	12	8	8	8	24	0	2	38	83	46
070503304	8	4	12	8	8	8	24	8	2	46	100	46
070503306	8	4	12	8	8	8	24	8	2	46	100	46
070503312	4	4	8	8	8	4	20	8	2	38	83	46
070503314	8	4	12	8	8	8	24	0	2	38	83	46
070503321	8	4	12	8	8	8	24	0	2	38	83	46
070503322	8	4	12	8	8	8	24	0	2	38	83	46
070503323	8	4	12	8	8	8	24	0	2	38	83	46
070503325	8	4	12	8	8	8	24	8	2	46	100	46
070503334	8	4	12	8	8	8	24	8	2	46	100	46
070503339	4	4	8	8	8	4	20	8	2	38	83	46
070503340	4	4	8	8	8	4	20	8	2	38	83	46
070503344	8	4	12	8	8	8	24	0	2	38	83	46
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070503407	8	4	12	8	8	8	24	0	2	38	83	46
070503409	8	4	12	8	8	8	24	0	2	38	83	46
070503411	8	4	12	8	8	8	24	8	2	46	100	46

070503417	8	4	12	8	8	8	24	0	2	38	83	46
070503420	8	4	12	0	8	0	8	8	0	28	61	46
070503421	8	4	12	8	8	8	24	0	0	36	78	46
070503424	8	4	12	0	8	0	8	8	0	28	61	46
070503425	8	4	12	8	8	8	24	0	0	36	78	46
070503430	8	4	12	8	8	8	24	8	2	46	100	46
070503432	8	4	12	8	8	8	24	8	2	46	100	46
070503502	8	4	12	8	8	8	24	8	2	46	100	46
070503503	4	4	8	8	8	4	20	8	2	38	83	46
070503505	8	4	12	8	8	8	24	0	2	38	83	46
070503506	8	4	12	8	8	8	24	0	2	38	83	46
070503507	8	4	12	8	8	8	24	8	2	46	100	46
070503508	8	4	12	8	8	8	24	8	2	46	100	46
070503509	4	4	8	8	8	4	20	8	2	38	83	46
070503511	8	4	12	8	8	8	24	0	2	38	83	46
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070503515	8	4	12	8	8	8	24	0	2	38	83	46
070503517	8	4	12	8	8	8	24	8	2	46	100	46
070503523	8	4	12	8	8	8	24	8	2	46	100	46
070503526	4	4	8	8	8	4	20	8	2	38	83	46
070503527	4	4	8	8	8	4	20	8	2	38	83	46
070503530	8	4	12	8	8	8	24	0	2	38	83	46
070503531	8	4	12	8	8	8	24	0	2	38	83	46
070503532	8	4	12	8	8	8	24	8	2	46	100	46

070503533	8	4	12	4	8	8	20	8	2	42	91	46
070503538	8	4	12	4	8	8	20	8	2	42	91	46
070503540	8	4	12	0	8	8	16	8	2	38	83	46
070503543	8	4	12	4	8	8	20	8	2	42	91	46
070503544	8	4	12	0	8	8	16	8	2	38	83	46
070503101	8	4	12	8	8	8	24	0	2	38	83	46
070503103	8	4	12	8	8	8	24	0	2	38	83	46
070503105	8	4	12	8	8	8	24	8	2	46	100	46
070503108	8	4	12	8	8	8	24	8	2	46	100	46
070503109	8	4	12	8	8	8	24	8	2	46	100	46
070503120	8	4	12	8	8	8	24	8	2	46	100	46
070503122	8	4	12	8	8	8	24	8	2	46	100	46
070503128	8	4	12	8	8	8	24	8	2	46	100	46
070503141	8	4	12	8	8	8	24	8	2	46	100	46
070503145	8	4	12	8	8	8	24	8	2	46	100	46
070503146	8	4	12	8	8	8	24	8	2	46	100	46
070503203	8	4	12	8	8	8	24	8	2	46	100	46
070503205	8	4	12	8	8	8	24	8	2	46	100	46
070503209	8	4	12	8	8	8	24	8	2	46	100	46
070503210	8	4	12	8	8	8	24	0	0	36	78	46
070503215	8	4	12	8	8	8	24	4	0	40	87	46
070503219	8	4	12	4	8	4	16	8	2	38	83	46
070503222	8	4	12	8	8	8	24	0	0	36	78	46
070503224	8	4	12	8	8	8	24	8	2	46	100	46
070503225	8	4	12	8	8	8	24	8	2	46	100	46

070503235	8	4	12	8	8	8	24	8	2	46	100	46
070503237	8	4	12	8	8	8	24	8	2	46	100	46
070503301	0	0	0	8	8	0	16	0	2	18	39	46
070503302	0	0	0	2	8	0	10	0	2	12	26	46
070503305	4	4	8	8	0	4	12	8	2	30	65	46
070503308	0	0	0	8	8	0	16	0	2	18	39	46
070503317	8	4	12	8	8	8	24	8	2	46	100	46
070503330	8	4	12	8	8	8	24	8	2	46	100	46
070503337	8	4	12	8	8	8	24	8	2	46	100	46
070503403	8	4	12	8	8	8	24	8	2	46	100	46
070503406	8	4	12	8	8	8	24	8	2	46	100	46
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070503436	8	4	12	8	8	8	24	8	2	46	100	46
070503438	8	4	12	8	8	8	24	8	2	46	100	46
070503504	8	4	12	8	8	8	24	8	2	46	100	46
070503516	8	4	12	8	8	8	24	8	2	46	100	46
070503521	8	4	12	8	8	8	24	8	2	46	100	46
070503528	8	4	12	8	8	8	24	8	2	46	100	46
070503539	8	4	12	8	8	8	24	8	2	46	100	46

070403141	8	4	12	8	8	8	24	8	2	46	100	46
070503107	8	4	12	8	8	8	24	8	2	46	100	46
070503110	8	4	12	8	8	8	24	8	2	46	100	46
070503112	8	4	12	8	8	8	24	8	2	46	100	46
070503113	8	4	12	8	8	8	24	8	2	46	100	46
070503114	8	4	12	8	8	8	24	8	2	46	100	46
070503115	8	4	12	8	8	8	24	8	2	46	100	46
070503117	8	4	12	8	8	8	24	8	2	46	100	46
070503121	8	4	12	8	8	8	24	8	2	46	100	46
070503124	8	4	12	8	8	8	24	8	2	46	100	46
070503125	8	4	12	4	8	8	20	8	2	42	91	46
070503126	8	4	12	4	8	8	20	8	2	42	91	46
070503129	8	4	12	0	8	8	16	8	2	38	83	46
070503133	8	4	12	4	8	8	20	8	2	42	91	46
070503134	8	4	12	0	8	8	16	8	2	38	83	46
070503135	8	4	12	8	8	8	24	8	2	46	100	46
070503136	8	4	12	4	8	8	20	8	2	42	91	46
070503137	8	4	12	4	8	8	20	8	2	42	91	46
070503139	8	4	12	0	8	8	16	8	2	38	83	46
070503140	8	4	12	4	8	8	20	8	2	42	91	46
070503142	8	4	12	0	8	8	16	8	2	38	83	46
070503143	8	4	12	8	8	8	24	8	2	46	100	46
070503201	8	4	12	8	8	8	24	8	2	46	100	46
070503202	8	4	12	8	8	8	24	8	2	46	100	46
070503204	8	4	12	8	8	8	24	8	2	46	100	46

070503207	8	4	12	8	8	8	24	8	2	46	100	46
070503213	8	4	12	8	8	8	24	8	2	46	100	46
070503214	8	4	12	8	8	8	24	8	2	46	100	46
070503216	8	4	12	8	8	8	24	8	2	46	100	46
070503217	8	4	12	0	8	8	16	8	2	38	83	46
070503220	8	4	12	8	8	8	24	8	2	46	100	46
070503221	8	4	12	8	8	8	24	8	2	46	100	46
070503223	8	4	12	8	8	8	24	8	2	46	100	46
070503226	8	4	12	8	8	8	24	8	2	46	100	46
070503227	8	4	12	8	8	8	24	8	2	46	100	46
070503229	8	4	12	8	8	8	24	8	2	46	100	46
070503230	8	4	12	8	8	8	24	8	2	46	100	46
070503232	8	4	12	8	8	8	24	8	2	46	100	46
070503234	8	4	12	8	8	8	24	0	0	36	78	46
070503240	8	4	12	8	8	8	24	8	2	46	100	46
070503243	8	4	12	8	8	8	24	8	2	46	100	46
070503245	8	4	12	8	8	8	24	8	2	46	100	46
070503246	8	4	12	8	8	8	24	8	2	46	100	46
070503303	8	4	12	8	8	8	24	8	2	46	100	46
070503307	8	4	12	8	8	8	24	8	2	46	100	46
070503309	8	4	12	8	8	8	24	0	0	36	78	46
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070503311	8	4	12	8	8	8	24	8	2	46	100	46
070503313	8	4	12	8	8	8	24	8	2	46	100	46
070503315	8	4	12	8	8	8	24	8	2	46	100	46

070503316	8	4	12	8	8	8	24	8	2	46	100	46
070503318	8	4	12	8	8	8	24	8	2	46	100	46
070503319	8	4	12	8	8	8	24	8	2	46	100	46
070503320	8	4	12	8	8	8	24	8	2	46	100	46
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070503326	8	4	12	8	8	8	24	0	2	38	83	46
070503327	8	4	12	8	8	8	24	0	2	38	83	46
070503328	8	4	12	8	8	8	24	0	2	38	83	46
070503329	8	4	12	8	8	8	24	0	2	38	83	46
070503332	8	4	12	8	8	8	24	8	2	46	100	46
070503333	8	4	12	8	8	8	24	8	2	46	100	46
070503335	8	4	12	8	8	8	24	8	2	46	100	46
070503336	8	4	12	8	8	8	24	0	2	38	83	46
070503341	8	4	12	8	8	8	24	0	2	38	83	46
070503343	8	4	12	8	8	8	24	0	2	38	83	46
070503344	8	4	12	8	8	8	24	0	2	38	83	46
070503345	8	4	12	8	8	8	24	8	2	46	100	46
070503346	8	4	12	8	8	8	24	8	2	46	100	46
070503410	8	4	12	8	8	8	24	8	2	46	100	46
070503415	8	4	12	8	8	8	24	0	2	38	83	46
070503426	8	4	12	8	8	8	24	0	2	38	83	46
070503428	8	4	12	8	8	8	24	0	2	38	83	46
070503431	8	4	12	8	8	8	24	0	2	38	83	46
070503439	8	4	12	8	8	8	24	8	2	46	100	46
070503440	8	4	12	8	8	8	24	8	2	46	100	46

070503442	8	4	12	8	8	8	24	8	2	46	100	46
070503443	8	4	12	8	8	8	24	0	2	38	83	46
070503444	8	4	12	8	8	8	24	0	2	38	83	46
070503445	8	4	12	8	8	8	24	0	2	38	83	46
070503501	8	4	12	8	8	8	24	0	2	38	83	46
070503510	8	4	12	8	8	8	24	0	2	38	83	46
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070503518	8	4	12	8	8	8	24	8	2	46	100	46
070503519	8	4	12	8	8	8	24	8	2	46	100	46
070503520	8	4	12	8	8	8	24	8	2	46	100	46
070503522	8	4	12	8	8	8	24	8	2	46	100	46
070503524	8	4	12	8	8	8	24	8	2	46	100	46
070503529	8	4	12	8	8	8	24	8	2	46	100	46
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070503533	8	4	12	8	8	8	24	0	2	38	83	46
070503534	8	4	12	8	8	8	24	0	2	38	83	46
070503536	8	4	12	8	8	8	24	0	2	38	83	46
070503538	8	4	12	8	8	8	24	8	2	46	100	46
070503542	8	4	12	8	8	8	24	8	2	46	100	46
070503545	8	4	12	8	8	8	24	8	2	46	100	46
070402545	8	4	12	8	8	8	24	8	2	46	100	46
070402530	8	4	12	8	8	8	24	8	2	46	100	46
070402613	8	4	12	8	8	8	24	8	2	46	100	46
070402636	8	4	12	8	8	8	24	8	2	46	100	46
070501402	8	4	12	8	8	8	24	8	2	46	100	46

070502108	8	4	12	8	8	8	24	8	2	46	100	46
070502114	8	4	12	8	8	8	24	8	2	46	100	46
070502117	8	4	12	8	8	8	24	8	2	46	100	46
070502126	8	4	12	2	8	8	18	8	2	40	87	46
070502133	8	4	12	8	8	8	24	8	2	46	100	46
Average score	7.705069	3.9447	11.64977	7.317972	7.963134	7.502304	22.78341	5.732719	1.880184	42.04608	91.40453	46

Appendix G: Data of Question 2 Performance

Subjects score of employee behaviour in Question 2 in test 2												
Items	**Direction of change**			Shape								
	increase or decrease	Accumulation: Maximum and minimum	Total of part 1	Continuity	Linear growth or Non-linear growth	Net flow = stock's slope	Total of part 2	Total Change	Initial Value	Total Score	correct pecentage	Full MARK
Student ID	Criterion 1	Criterion 2		Criterion 3	Criterion 4	Criterion 5		Criterion 6	Criterion 7			
070503102	4	4	8	8	8	4	20	8	2	38	83	46
070503106	4	4	8	8	8	4	20	8	2	38	83	46
070503109	4	4	8	8	8	4	20	8	2	38	83	46
070503111	4	4	8	8	8	4	20	0	2	30	65	46
070503116	4	4	8	8	8	4	20	0	2	30	65	46
070503119	4	4	8	8	8	8	24	0	2	34	74	46
070503123	4	4	8	0	8	0	8	8	2	26	57	46
070503127	4	4	8	8	8	4	20	0	2	30	65	46
070503130	4	4	8	8	8	4	20	0	2	30	65	46
070503131	4	4	8	8	8	4	20	0	2	30	65	46
070503132	4	4	8	8	8	4	20	0	2	30	65	46
070503138	4	4	8	0	8	0	8	8	0	24	52	46

070503144	4	4	8	8	8	8	24	0	0	32	70	46
070503228	4	4	8	0	8	0	8	8	0	24	52	46
070503236	4	4	8	8	8	8	24	0	0	32	70	46
070503238	4	4	8	8	8	4	20	8	2	38	83	46
070503239	4	4	8	8	8	8	24	8	2	42	91	46
070503242	4	4	8	8	8	8	24	8	2	42	91	46
070503243	4	4	8	8	8	4	20	8	2	38	83	46
070503244	8	4	12	8	8	8	24	0	2	38	83	46
070503246	4	4	8	8	8	8	24	0	2	34	74	46
070503304	4	4	8	8	8	8	24	8	2	42	91	46
070503306	4	4	8	8	8	8	24	8	2	42	91	46
070503312	4	4	8	8	8	4	20	8	2	38	83	46
070503314	4	4	8	8	8	4	20	0	2	30	65	46
070503321	4	4	8	8	8	8	24	0	2	34	74	46
070503322	4	4	8	8	8	4	20	0	2	30	65	46
070503323	4	4	8	8	8	8	24	0	2	34	74	46
070503325	4	4	8	8	8	8	24	8	2	42	91	46
070503334	4	4	8	8	8	8	24	8	2	42	91	46
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070502114	4	4	8	8	8	8	24	8	2	42	91	46
070502117	4	4	8	8	8	8	24	8	2	42	91	46
070502126	4	4	8	2	8	8	18	8	2	36	78	46
070502133	8	4	12	8	8	8	24	8	2	46	100	46
Average score	6.101382488	3.944700461	10.04604608295	7.31797235	7.963133641	6.728110599	22.00921659	5.732718894	1.880184332	39.66820276	86.2352234	46

Subjects score of employee behaviour in Question 2 in test 3												
	Direction of change			Shape								
Items	increase or decrease	Accumulation: Maximum and minimum	Total of part 1	Continuity	Linear growth or Non-linear growth	Net flow = stock's slope	Total of part 2	Total Change	Initial Value	Total Score	correct pecentage	Full MARK
Student ID	Criterion 1	Criterion 2		Criterion 3	Criterion 4	Criterion 5		Criterion 6	Criterion 7			
070503102	8	4	12	8	8	8	24	8	2	46	100	46
070503106	8	4	12	8	8	8	24	8	2	46	100	46
070503109	4	4	8	8	8	4	20	8	2	38	83	46
070503111	8	4	12	8	8	8	24	0	2	38	83	46

070503116	8	4	12	8	8	8	24	0	2	38	83	46
070503119	4	4	8	8	8	8	24	0	2	34	74	46
070503123	8	4	12	0	8	0	8	8	2	30	65	46
070503127	8	4	12	8	8	8	24	0	2	38	83	46
070503130	8	4	12	8	8	8	24	0	2	38	83	46
070503131	8	4	12	8	8	8	24	0	2	38	83	46
070503132	8	4	12	8	8	8	24	0	2	38	83	46
070503138	8	4	12	0	8	0	8	8	0	28	61	46
070503144	8	4	12	8	8	8	24	0	0	36	78	46
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070503236	8	4	12	8	8	8	24	0	0	36	78	46
070503238	8	4	12	8	8	8	24	8	2	46	100	46
070503239	4	4	8	8	8	8	24	8	2	42	91	46
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070503243	4	4	8	8	8	4	20	8	2	38	83	46
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070503325	8	4	12	8	8	8	24	8	2	46	100	46

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070503344	8	4	12	8	8	8	24	0	2	38	83	46
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070503105	8	4	12	8	8	8	24	8	2	46	100	46
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070503146	8	4	12	8	8	8	24	8	2	46	100	46
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070402613	8	4	12	8	8	8	24	8	2	46	100	46
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070502108	8	4	12	8	8	8	24	8	2	46	100	46
070502114	8	4	12	8	8	8	24	8	2	46	100	46
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070502126	8	4	12	2	8	8	18	8	2	40	87	46
070502133	8	4	12	8	8	8	24	8	2	46	100	46
Average score	7.686635945	3.944700461	11.63133641	7.299539171	7.907834101	7.502304147	22.70967742	5.732718894	1.880184332	41.95391705	91.2041675	46

Subjects score of *project work done* behaviour in Question 2 in test 2												
	Direction of change			Shape								
Items	increase or decrease	Accumulation: Maximum and minimum	Total of part 1	Continuity	Linear growth or Non-linear growth	Net flow = stock's slope	Total of part 2	Total Change	Initial Value	Total Score	correct pecentage	Full MARK
Student ID	Criterio	Criterion 2		Criterion 3	Criterion 4	Criterion 5		Criterion 6	Criterion 7			

	n 1											
070503102	0	0	0	2	0	0	2	0	2	4	9	46
070503106	0	0	0	2	4	0	6	0	2	8	17	46
070503109	0	4	4	8	0	4	12	8	2	26	57	46
070503111	0	0	0	2	2	0	4	0	2	6	13	46
070503116	0	4	4	2	0	0	2	0	0	6	13	46
070503119	0	4	4	2	0	0	2	0	2	8	17	46
070503123	0	4	4	0	0	0	0	8	0	12	26	46
070503127	0	4	4	0	0	0	0	6	2	12	26	46
070503130	0	4	4	0	0	0	0	8	0	12	26	46
070503131	0	4	4	0	0	0	0	6	2	12	26	46
070503132	0	0	0	2	2	0	4	0	2	6	13	46
070503138	0	4	4	0	8	4	12	6	2	24	52	46
070503144	0	4	4	0	0	0	0	8	0	12	26	46
070503228	0	0	0	2	2	0	4	0	2	6	13	46
070503236	0	4	4	2	2	2	6	0	0	10	22	46
070503238	0	0	0	2	2	0	4	0	2	6	13	46
070503239	0	0	0	2	2	0	4	0	2	6	13	46
070503242	0	4	4	8	0	4	12	8	2	26	57	46
070503243	0	0	0	2	2	0	4	0	2	6	13	46
070503244	4	4	8	8	8	8	24	0	0	32	70	46
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070503304	0	0	0	8	8	0	16	0	2	18	39	46
070503306	0	0	0	2	8	0	10	0	2	12	26	46
070503312	4	4	8	8	0	0	8	8	2	26	57	46

070503314	4	0	4	2	2	0	4	0	2	10	22	46
070503321	4	4	8	8	8	8	24	0	0	32	70	46
070503322	4	0	4	2	8	0	10	0	2	16	35	46
070503323	0	4	4	8	0	4	12	8	2	26	57	46
070503325	0	0	0	2	2	0	4	0	2	6	13	46
070503334	0	4	4	0	8	0	8	8	0	20	43	46
070503339	0	4	4	0	8	4	12	6	2	24	52	46
070503340	0	0	0	2	2	0	4	0	2	6	13	46
070503344	0	4	4	0	8	4	12	6	2	24	52	46
070503402	0	4	4	0	8	0	8	8	0	20	43	46
070503407	0	0	0	2	2	0	4	0	2	6	13	46
070503409	0	4	4	8	8	8	24	0	0	28	61	46
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070503417	0	0	0	2	8	0	10	0	2	12	26	46
070503420	0	4	4	8	0	4	12	8	2	26	57	46
070503421	0	0	0	2	2	0	4	0	2	6	13	46
070503424	0	4	4	8	8	8	24	0	0	28	61	46
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070503430	0	4	4	8	0	4	12	8	2	26	57	46
070503432	4	0	4	2	2	0	4	0	2	10	22	46
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070503503	0	4	4	0	8	0	8	4	0	16	35	46
070503505	4	4	8	0	8	4	12	6	2	28	61	46
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070503507	4	4	8	0	8	4	12	6	2	28	61	46
070503508	4	4	8	0	8	0	8	8	0	24	52	46
070503509	0	0	0	2	2	0	4	0	2	6	13	46
070503511	0	4	4	8	8	8	24	0	0	28	61	46
070503512	0	0	0	4	8	0	12	0	2	14	30	46
070503514	0	0	0	2	8	0	10	0	2	12	26	46
070503515	0	4	4	8	0	4	12	8	2	26	57	46
070503517	4	0	4	2	2	0	4	0	2	10	22	46
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070503526	0	0	0	8	8	0	16	0	2	18	39	46
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070503530	4	4	8	8	0	4	12	8	2	30	65	46
070503531	4	0	4	2	2	0	4	0	2	10	22	46
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070503533	8	4	12	0	8	0	8	4	2	26	57	46
070503538	8	4	12	0	8	0	8	4	2	26	57	46
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070503101	4	4	8	8	8	8	24	0	0	32	70	46
070503103	4	4	8	8	8	8	24	0	0	32	70	46
070503105	4	4	8	4	4	4	12	8	0	28	61	46
070503108	4	4	8	4	4	4	12	8	0	28	61	46
070503109	4	4	8	4	4	4	12	8	2	30	65	46
070503120	0	4	4	8	8	8	24	0	0	28	61	46

070503122	0	0	0	8	8	0	16	0	2	18	39	46
070503128	0	0	0	2	8	0	10	0	2	12	26	46
070503141	0	4	4	8	0	4	12	8	2	26	57	46
070503145	0	0	0	2	2	0	4	0	2	6	13	46
070503146	4	4	8	8	8	8	24	0	0	32	70	46
070503203	4	4	8	8	8	8	24	0	0	32	70	46
070503205	4	0	4	2	8	0	10	0	2	16	35	46
070503209	4	4	8	8	0	4	12	8	2	30	65	46
070503210	4	0	4	2	2	0	4	0	2	10	22	46
070503215	4	4	8	0	8	0	8	4	0	20	43	46
070503219	4	4	8	0	8	4	12	6	2	28	61	46
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070503225	4	4	8	4	4	4	12	8	0	28	61	46
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070503237	4	4	8	8	8	8	24	8	2	42	91	46
070503301	0	0	0	8	8	0	16	0	2	18	39	46
070503302	0	0	0	2	8	0	10	0	2	12	26	46
070503305	0	4	4	8	0	4	12	8	2	26	57	46
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070503414	0	4	4	0	8	4	12	6	2	24	52	46
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070503504	4	4	8	8	8	8	24	8	2	42	91	46
070503516	4	0	4	8	8	0	16	0	2	22	48	46
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070503528	4	4	8	8	0	4	12	8	2	30	65	46
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070403141	4	4	8	8	8	8	24	0	0	32	70	46
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070503113	0	4	4	8	8	8	24	8	2	38	83	46
070503114	0	4	4	8	8	8	24	8	0	36	78	46
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070503117	0	4	4	8	8	8	24	8	2	38	83	46
070503121	0	0	0	8	8	0	16	0	2	18	39	46
070503124	0	0	0	2	8	0	10	0	2	12	26	46
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070503126	4	0	4	2	2	0	4	0	2	10	22	46
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070503133	4	4	8	8	0	4	12	8	2	30	65	46
070503134	4	0	4	2	2	0	4	0	2	10	22	46
070503135	4	4	8	8	8	8	24	0	0	32	70	46
070503136	4	4	8	8	8	8	24	0	2	34	74	46
070503137	4	4	8	0	8	0	8	8	0	24	52	46
070503139	8	4	12	0	8	4	12	6	2	32	70	46
070503140	8	4	12	0	8	0	8	8	0	28	61	46
070503142	8	4	12	0	8	4	12	6	2	32	70	46
070503143	8	0	8	2	2	0	4	0	2	14	30	46
070503201	8	0	8	2	2	0	4	0	2	14	30	46
070503202	4	4	8	8	8	8	24	0	0	32	70	46
070503204	4	4	8	8	8	8	24	0	2	34	74	46
070503207	4	4	8	0	8	0	8	8	0	24	52	46
070503213	4	4	8	0	8	4	12	6	2	28	61	46
070503214	4	4	8	0	8	0	8	8	0	24	52	46
070503216	4	4	8	0	8	4	12	6	2	28	61	46
070503217	4	0	4	2	2	0	4	0	2	10	22	46
070503220	4	4	8	0	8	4	12	6	2	28	61	46
070503221	4	4	8	0	8	0	8	8	0	24	52	46
070503223	4	0	4	2	2	0	4	0	2	10	22	46
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070503227	4	0	4	8	8	0	16	0	2	22	48	46
070503229	4	0	4	2	8	0	10	0	2	16	35	46

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070503234	4	4	8	8	8	8	24	0	0	32	70	46
070503240	4	4	8	8	8	8	24	0	0	32	70	46
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070503245	4	0	4	2	8	0	10	0	2	16	35	46
070503246	4	4	8	8	0	4	12	8	2	30	65	46
070503303	4	0	4	2	2	0	4	0	2	10	22	46
070503307	0	4	4	8	8	8	24	0	0	28	61	46
070503309	0	0	0	2	2	0	4	0	2	6	13	46
070503310	0	0	0	2	8	0	10	0	2	12	26	46
070503311	0	4	4	8	0	4	12	8	2	26	57	46
070503313	0	0	0	2	2	0	4	0	2	6	13	46
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070503316	0	4	4	8	8	8	24	0	2	30	65	46
070503318	0	4	4	0	8	0	8	8	0	20	43	46
070503319	0	4	4	0	8	4	12	6	2	24	52	46
070503320	0	4	4	0	8	0	8	8	0	20	43	46
070503324	0	4	4	0	8	4	12	6	2	24	52	46
070503326	4	0	4	2	2	0	4	0	2	10	22	46
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070503328	4	4	8	8	8	8	24	0	0	32	70	46
070503329	4	4	8	8	8	8	24	0	2	34	74	46
070503332	0	4	4	0	8	0	8	8	0	20	43	46
070503333	4	4	8	0	8	4	12	6	2	28	61	46

070503335	0	4	4	0	8	0	8	8	0	20	43	46
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070503341	0	0	0	2	2	0	4	0	2	6	13	46
070503343	0	4	4	0	8	4	12	6	2	24	52	46
070503344	0	4	4	0	8	0	8	8	0	20	43	46
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070503346	8	4	12	8	8	8	24	0	0	36	78	46
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070503510	4	0	4	2	2	0	4	0	2	10	22	46
070503513	4	0	4	2	2	0	4	0	2	10	22	46
070503518	4	4	8	8	8	8	24	0	0	32	70	46
070503519	4	4	8	8	8	8	24	0	2	34	74	46
070503520	4	4	8	0	8	0	8	8	0	24	52	46
070503522	4	4	8	0	8	4	12	6	2	28	61	46

070503524	4	4	8	0	8	0	8	8	0	24	52	46
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070503532	4	0	4	2	2	0	4	0	2	10	22	46
070503533	4	4	8	0	8	4	12	6	2	28	61	46
070503534	4	4	8	0	8	0	8	8	0	24	52	46
070503536	4	0	4	2	2	0	4	0	2	10	22	46
070503538	4	4	8	8	8	8	24	0	0	32	70	46
070503542	4	0	4	8	8	0	16	0	2	22	48	46
070503545	4	0	4	2	8	0	10	0	2	16	35	46
070402545	4	4	8	8	0	4	12	8	2	30	65	46
070402530	4	0	4	2	2	0	4	0	2	10	22	46
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070502108	0	0	0	8	8	0	16	0	2	18	39	46
070502114	0	0	0	2	8	0	10	0	2	12	26	46
070502117	0	4	4	8	0	4	12	8	2	26	57	46
070502126	0	0	0	2	2	0	4	0	2	6	13	46
070502133	4	4	8	8	8	8	24	0	0	32	70	46
Average score	2.4884 79263	2.59907834 1	5.0875576 04	4.0737327 19	5.5668202 76	2.9953917 05	12.63594 47	3.0783410 14	1.2995391 71	22.101382 49	48.046483 67	46

Subjects score of *project work done* behaviour in Question 2 in test 3											
Items	Direction of change			Shape				Total Change	Initial Value	Total Score	correct pecentage	Full MARK
	increase or decrease	Accumulation: Maximum and minimum	Total of part 1	Continuity	Linear growth or Non-linear growth	Net flow = stock's slope	Total of part 2					
Student ID	Criterion 1	Criterion 2		Criterion 3	Criterion 4	Criterion 5		Criterion 6	Criterion 7			
070503102	8	0	8	8	8	8	24	0	2	34	74	46
070503106	8	0	8	6	8	8	22	0	2	32	70	46
070503109	4	4	8	8	0	0	8	8	2	26	57	46
070503111	8	0	8	6	2	2	10	0	2	20	43	46
070503116	8	4	12	8	8	8	24	0	2	38	83	46
070503119	4	4	8	8	8	8	24	0	2	34	74	46
070503123	8	4	12	0	8	8	16	8	0	36	78	46
070503127	8	4	12	0	8	8	16	6	2	36	78	46
070503130	8	4	12	4	8	8	20	8	0	40	87	46
070503131	8	4	12	4	8	8	20	6	2	40	87	46
070503132	8	0	8	6	2	2	10	0	2	20	43	46
070503138	8	4	12	8	8	8	24	6	2	44	96	46
070503144	8	4	12	4	8	8	20	8	0	40	87	46
070503228	8	0	8	6	2	2	10	0	2	20	43	46

070503236	8	4	12	8	8	8	24	0	0	36	78	46
070503238	8	0	8	8	8	8	24	0	2	34	74	46
070503239	4	0	4	6	8	8	22	0	2	28	61	46
070503242	8	4	12	8	0	0	8	8	2	30	65	46
070503243	4	0	4	6	2	2	10	0	2	16	35	46
070503244	8	4	12	8	8	8	24	0	0	36	78	46
070503246	8	4	12	8	8	8	24	0	0	36	78	46
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070503306	8	0	8	6	8	8	22	0	2	32	70	46
070503312	8	4	12	8	0	0	8	8	2	30	65	46
070503314	8	0	8	6	2	2	10	0	2	20	43	46
070503321	8	4	12	8	8	8	24	0	0	36	78	46
070503322	8	0	8	6	8	8	22	0	2	32	70	46
070503323	8	4	12	8	0	0	8	8	2	30	65	46
070503325	8	0	8	6	2	2	10	0	2	20	43	46
070503334	8	4	12	4	8	8	20	8	0	40	87	46
070503339	4	4	8	4	8	8	20	6	2	36	78	46
070503340	4	0	4	6	2	2	10	0	2	16	35	46
070503344	8	4	12	4	8	8	20	6	2	40	87	46
070503402	8	4	12	4	8	8	20	8	0	40	87	46
070503407	8	0	8	2	2	2	6	0	2	16	35	46
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070503411	8	0	8	8	8	8	24	0	2	34	74	46
070503417	8	0	8	6	8	8	22	0	2	32	70	46
070503420	8	4	12	8	0	0	8	8	2	30	65	46

070503421	8	0	8	6	2	2	10	0	2	20	43	46
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070503430	8	4	12	8	0	0	8	8	2	30	65	46
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070503502	8	4	12	8	8	8	24	0	0	36	78	46
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070503506	8	4	12	6	2	2	10	0	2	24	52	46
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070503515	8	4	12	8	0	8	16	8	2	38	83	46
070503517	8	0	8	6	2	2	10	0	2	20	43	46
070503523	8	4	12	4	8	8	20	4	2	38	83	46
070503526	8	0	8	8	8	8	24	0	2	34	74	46
070503527	8	0	8	6	8	8	22	0	2	32	70	46
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070503532	8	4	12	8	0	8	16	8	2	38	83	46
070503533	8	4	12	4	8	8	20	4	2	38	83	46
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070503543	8	4	12	4	8	8	20	4	2	38	83	46
070503544	8	4	12	4	8	8	20	4	2	38	83	46
070503101	8	4	12	8	8	8	24	8	0	44	96	46
070503103	8	4	12	8	8	8	24	8	0	44	96	46
070503105	8	4	12	8	8	8	24	8	0	44	96	46
070503108	8	4	12	8	8	8	24	8	0	44	96	46
070503109	8	4	12	8	8	8	24	8	2	46	100	46
070503120	8	4	12	8	8	8	24	8	0	44	96	46
070503122	8	0	8	8	8	8	24	8	2	42	91	46
070503128	8	0	8	6	8	8	22	8	2	40	87	46
070503141	8	4	12	8	0	8	16	8	2	38	83	46
070503145	8	0	8	6	2	8	16	8	2	34	74	46
070503146	8	4	12	8	8	8	24	8	0	44	96	46
070503203	8	4	12	8	8	8	24	8	0	44	96	46
070503205	8	0	8	6	8	8	22	8	2	40	87	46
070503209	8	4	12	8	0	8	16	8	2	38	83	46
070503210	8	0	8	6	2	8	16	8	2	34	74	46
070503215	8	4	12	4	8	8	20	4	0	36	78	46
070503219	8	4	12	4	8	8	20	6	2	40	87	46
070503222	8	4	12	8	8	8	24	6	0	42	91	46
070503224	8	4	12	8	8	8	24	0	0	36	78	46
070503225	8	4	12	8	8	8	24	8	0	44	96	46
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070503237	8	4	12	8	8	8	24	8	2	46	100	46

070503301	8	4	12	8	8	8	24	8	2	46	100	46
070503302	8	4	12	6	8	8	22	8	2	44	96	46
070503305	8	4	12	8	0	0	8	8	2	30	65	46
070503308	8	4	12	6	2	2	10	8	2	32	70	46
070503317	8	4	12	8	8	8	24	8	2	46	100	46
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070403141	8	4	12	8	8	8	24	8	2	46	100	46
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070503114	8	4	12	8	8	8	24	8	0	44	96	46
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070503125	8	4	12	8	0	0	8	8	2	30	65	46
070503126	8	0	8	6	2	2	10	0	2	20	43	46
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070503133	8	4	12	8	0	0	8	8	2	30	65	46
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070503136	8	4	12	8	8	8	24	0	2	38	83	46
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070503143	8	0	8	6	2	2	10	0	2	20	43	46
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070503202	8	4	12	8	8	8	24	0	0	36	78	46
070503204	8	4	12	8	8	8	24	0	2	38	83	46
070503207	8	4	12	4	8	8	20	8	0	40	87	46
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070503324	8	4	12	4	8	8	20	6	2	40	87	46
070503326	8	0	8	6	2	2	10	6	2	26	57	46
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070503329	8	4	12	8	8	8	24	6	2	44	96	46
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070503333	8	4	12	4	8	8	20	6	2	40	87	46
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070503343	8	4	12	4	8	8	20	6	2	40	87	46
070503344	8	4	12	4	8	8	20	8	0	40	87	46
070503345	8	0	8	6	2	2	10	8	2	28	61	46
070503346	8	4	12	8	8	8	24	8	0	44	96	46
070503410	8	0	8	8	8	8	24	8	2	42	91	46
070503415	8	0	8	6	8	8	22	8	2	40	87	46
070503426	8	4	12	8	0	0	8	8	2	30	65	46
070503428	8	0	8	6	2	2	10	8	2	28	61	46
070503431	8	4	12	8	0	0	8	8	2	30	65	46
070503439	8	0	8	6	2	2	10	8	2	28	61	46
070503440	8	4	12	8	8	8	24	8	0	44	96	46
070503442	8	4	12	8	8	8	24	8	2	46	100	46
070503443	8	4	12	4	8	8	20	8	0	40	87	46

070503444	8	4	12	4	8	8	20	6	2	40	87	46
070503445	8	4	12	4	8	8	20	8	0	40	87	46
070503501	8	4	12	4	8	8	20	6	2	40	87	46
070503510	8	4	12	6	2	8	16	6	2	36	78	46
070503513	8	4	12	6	2	8	16	6	2	36	78	46
070503518	8	4	12	8	8	8	24	6	0	42	91	46
070503519	8	4	12	8	8	8	24	6	2	44	96	46
070503520	8	4	12	8	8	8	24	8	0	44	96	46
070503522	8	4	12	8	8	8	24	6	2	44	96	46
070503524	8	4	12	8	8	8	24	8	0	44	96	46
070503529	8	4	12	8	8	8	24	6	2	44	96	46
070503532	8	4	12	8	2	8	18	0	2	32	70	46
070503533	8	4	12	8	8	8	24	6	2	44	96	46
070503534	8	4	12	8	8	8	24	8	0	44	96	46
070503536	8	4	12	8	2	8	18	0	2	32	70	46
070503538	8	4	12	8	8	8	24	0	0	36	78	46
070503542	8	4	12	8	8	8	24	0	2	38	83	46
070503545	8	4	12	8	8	8	24	0	2	38	83	46
070402545	8	4	12	8	0	8	16	8	2	38	83	46
070402530	8	4	12	8	2	8	18	8	2	40	87	46
070402613	8	4	12	8	8	8	24	8	2	46	100	46
070402636	8	4	12	8	2	2	12	8	2	34	74	46
070501402	8	4	12	8	8	8	24	8	2	46	100	46
070502108	8	4	12	8	8	8	24	0	2	38	83	46
070502114	8	4	12	6	8	8	22	0	2	36	78	46

070502117	8	4	12	8	0	0	8	8	2	30	65	46
070502126	8	4	12	6	2	2	10	8	2	32	70	46
070502133	8	4	12	8	8	8	24	8	0	44	96	46
Average score	7.889400922	2.930875576	10.8202765	6.562211982	6.055299539	6.433179724	19.05069124	5.198156682	1.493087558	36.56221198	79.48306953	46

Appendix H: Data of Question 3 Performance

Subjects score of Question 3 in test 1																
Items	Dependency			time					resource		Labor curve				Total Score of question 3	full mark
Student ID	Finish to start	Start to Start	Total Score of Dependency	Earliest start time	Earliest finish time	Duration	Schedule	Total Score of time	Resource occupied	Total Score of resource	Human resource Value	time axis	line	Total score of Labor curve		
070503102	4	2	6	4	4	12	0	20	12	12	0	0	0	0	38	120
070503106	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503109	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503111	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503116	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503119	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503123	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503127	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
070503130	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503131	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503132	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120

070503138	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503144	6	2	8	10	10	12	0	32	12	12	10	10	18	38	90	120
070503228	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503236	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503238	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503239	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503242	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503243	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503244	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503246	6	2	8	10	10	12	0	32	12	12	10	10	20	40	92	120
070503304	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503306	6	2	8	10	10	12	0	32	12	12	8	8	20	36	88	120
070503312	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503314	4	2	6	4	4	12	0	20	12	12	0	0	0	0	38	120
070503321	4	2	6	4	4	12	0	20	12	12	0	0	0	0	38	120
070503322	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503323	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
070503325	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503334	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503339	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503340	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503344	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503402	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503407	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503409	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120

070503411	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503417	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503420	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503421	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503424	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503425	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503430	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503432	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503502	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503503	8	2	10	10	10	12	0	32	12	12	10	0	0	10	64	120
070503505	8	2	10	8	8	12	0	28	12	12	10	0	0	10	60	120
070503506	8	2	10	8	6	12	0	26	12	12	10	0	0	10	58	120
070503507	8	2	10	6	6	12	0	24	12	12	10	0	0	10	56	120
070503508	6	2	8	10	10	12	0	32	12	12	10	10	20	40	92	120
070503509	4	2	6	4	4	12	0	20	12	12	0	0	20	20	58	120
070503511	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503512	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503514	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070503515	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503517	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503523	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503526	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503527	8	2	10	10	10	12	0	32	12	12	8	8	0	16	70	120
070503530	8	2	10	8	8	12	0	28	12	12	8	8	0	16	66	120
070503531	8	2	10	8	8	12	0	28	12	12	8	8	0	16	66	120

070503532	8	2	10	10	10	12	0	32	12	12	8	8	0	16	70	120
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070503538	8	2	10	8	6	12	0	26	12	12	8	0	0	8	56	120
070503540	8	2	10	6	6	12	0	24	12	12	8	0	0	8	54	120
070503543	6	2	8	10	10	12	0	32	12	12	8	8	10	26	78	120
070503544	4	2	6	4	4	12	0	20	12	12	2	2	20	24	62	120
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070503103	6	2	8	10	10	12	0	32	12	12	0	0	20	20	72	120
070503105	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503108	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503109	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503120	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503122	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503128	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503141	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503145	6	2	8	10	10	12	0	32	12	12	8	8	18	34	86	120
070503146	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503203	6	2	8	10	10	12	0	32	12	12	0	0	20	20	72	120
070503205	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503209	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
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070503222	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503224	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120

070503225	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
070503235	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503237	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503301	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503302	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503305	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503308	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503317	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503330	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
070503337	4	2	6	4	4	12	0	20	12	12	2	2	0	4	42	120
070503403	4	2	6	4	4	12	0	20	12	12	2	2	10	14	52	120
070503406	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503413	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503414	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503416	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503418	4	2	6	4	4	12	0	20	12	12	2	4	0	6	44	120
070503433	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503434	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503435	4	2	6	4	4	12	0	20	12	12	4	2	0	6	44	120
070503436	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503438	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503504	4	2	6	4	4	12	0	20	12	12	2	2	12	16	54	120
070503516	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503521	4	2	6	4	4	12	0	20	12	12	2	2	12	16	54	120
070503528	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120

070503539	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070403141	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503107	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503110	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503112	8	2	10	10	10	12	0	32	12	12	10	0	0	10	64	120
070503113	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503114	6	2	8	10	10	12	0	32	12	12	8	8	20	36	88	120
070503115	4	2	6	4	4	12	0	20	12	12	2	2	0	4	42	120
070503117	4	2	6	4	4	12	0	20	12	12	2	2	0	4	42	120
070503121	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503124	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
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070503126	8	2	10	0	0	0	0	0	0	0	0	0	18	18	28	120
070503129	8	2	10	6	6	12	0	24	12	12	6	6	18	30	76	120
070503133	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503134	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503135	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503136	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503137	8	2	10	0	0	0	0	0	0	0	0	0	18	18	28	120
070503139	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503140	8	2	10	12	12	12	2	38	12	12	6	6	0	12	72	120
070503142	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503143	8	2	10	12	12	12	2	38	12	12	0	0	0	0	60	120
070503201	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503202	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120

070503204	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503207	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503213	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503214	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503216	8	2	10	10	10	12	0	32	12	12	10	0	0	10	64	120
070503217	8	2	10	8	8	12	0	28	12	12	10	0	0	10	60	120
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070503223	6	2	8	10	10	12	0	32	12	12	6	6	18	30	82	120
070503226	4	2	6	4	4	12	0	20	12	12	4	4	4	12	50	120
070503227	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503229	4	2	6	4	4	12	0	20	12	12	4	4	4	12	50	120
070503230	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070503232	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
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070503240	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503243	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503245	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503246	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503303	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070503307	8	2	10	8	8	12	0	28	12	12	10	0	0	10	60	120
070503309	8	2	10	8	6	12	0	26	12	12	10	0	0	10	58	120
070503310	8	2	10	6	6	12	0	24	12	12	10	0	0	10	56	120
070503311	6	2	8	10	10	12	0	32	12	12	8	8	20	36	88	120
070503313	4	2	6	4	4	12	0	20	12	12	4	4	16	24	62	120

070503315	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503316	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503318	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070503319	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
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070503324	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503326	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
070503327	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503328	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503329	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070503332	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503333	4	2	6	4	4	12	0	20	12	12	4	4	12	20	58	120
070503335	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503336	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
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070503343	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503344	8	2	10	6	6	12	0	24	12	12	6	6	12	24	70	120
070503345	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503346	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503410	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503415	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503426	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503428	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503431	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503439	8	2	10	6	6	12	0	24	12	12	6	6	18	30	76	120

070503440	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503442	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503443	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503444	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503445	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503501	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070503510	4	2	6	4	4	12	0	20	12	12	4	4	18	26	64	120
070503513	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503518	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503519	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503520	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070503522	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503524	8	2	10	6	6	12	0	24	12	12	6	6	18	30	76	120
070503529	4	2	6	4	4	12	0	20	12	12	4	4	20	28	66	120
070503532	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503533	8	2	10	6	6	12	0	24	12	12	0	0	0	0	46	120
070503534	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503536	8	2	10	0	0	0	0	0	0	0	0	0	0	0	10	120
070503538	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503542	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503545	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070402545	8	2	10	10	10	12	0	32	12	12	10	0	0	10	64	120
070402530	8	2	10	8	8	12	0	28	12	12	10	0	0	10	60	120
070402613	8	2	10	8	6	12	0	26	12	12	10	0	0	10	58	120
070402636	8	2	10	6	6	12	0	24	12	12	10	0	0	10	56	120

Student ID	Finish to start	Start to Start	Total Score of Dependency	Earliest start time	Earliest finish time	Duration	Schedule	Total Score of time	Resource occupied	Total Score of resource	Human resource Value	time axis	line	Total score of Labor curve	Total Score of question 3	full mark
070501402	6	2	8	10	10	12	0	32	12	12	8	8	18	34	86	120
070502108	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070502114	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070502117	4	2	6	4	4	12	0	20	12	12	4	4	0	8	46	120
070502126	0	2	2	2	2	12	0	16	12	12	2	2	0	4	34	120
070502133	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
Average score	6.47	2	8.47	6.092	6.046	9.677	0.507	22.32	9.677	9.677	6.065	3.779	6.101	15.94	56.41	120

Subjects score of Question 3 in post test																
Items	Dependency			time					resource		Labor curve				Total Score of question 3	full mark
Student ID	Finish to start	Start to Start	Total Score of Dependency	Earliest start time	Earliest finish time	Duration	Schedule	Total Score of time	Resource occupied	Total Score of resource	Human resource Value	time axis	line	Total score of Labor curve		
070503102	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503106	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503109	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503111	8	2	10	8	8	12	0	28	12	12	10	10	18	38	88	120

070503116	8	2	10	8	8	12	0	28	12	12	10	10	18	38	88	120
070503119	8	2	10	8	8	12	0	28	12	12	0	0	18	18	68	120
070503123	8	2	10	8	8	12	0	28	12	12	0	0	18	18	68	120
070503127	8	2	10	12	12	12	2	38	12	12	18	18	18	54	114	120
070503130	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503131	8	2	10	10	12	12	2	36	12	12	10	10	18	38	96	120
070503132	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503138	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503144	8	2	10	12	12	12	2	38	12	12	12	12	18	42	102	120
070503228	8	2	10	12	10	10	0	32	12	12	10	10	18	38	92	120
070503236	8	2	10	12	10	10	0	32	12	12	10	10	18	38	92	120
070503238	8	2	10	12	10	10	0	32	12	12	8	8	18	34	88	120
070503239	8	2	10	12	10	10	0	32	12	12	12	12	18	42	96	120
070503242	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503243	8	2	10	12	12	12	2	38	12	12	12	12	20	44	104	120
070503244	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503246	8	2	10	12	12	12	2	38	12	12	16	16	20	52	112	120
070503304	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503306	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503312	8	2	10	12	12	12	2	38	12	12	10	10	18	38	98	120
070503314	8	2	10	12	6	6	0	24	12	12	8	8	18	34	80	120
070503321	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503322	8	2	10	12	12	12	2	38	12	12	16	16	18	50	110	120
070503323	8	2	10	12	12	12	2	38	12	12	16	16	18	50	110	120
070503325	8	2	10	12	12	12	2	38	12	12	16	16	18	50	110	120

070503334	8	2	10	12	10	10	2	34	12	12	16	16	18	50	106	120
070503339	8	2	10	12	12	12	2	38	12	12	16	16	18	50	110	120
070503340	8	2	10	12	12	12	2	38	12	12	16	16	18	50	110	120
070503344	8	2	10	12	10	10	0	32	12	12	0	0	18	18	72	120
070503402	8	2	10	12	12	12	0	36	12	12	0	0	18	18	76	120
070503407	8	2	10	12	12	12	0	36	12	12	0	0	18	18	76	120
070503409	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503411	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503417	8	2	10	12	12	12	2	38	12	12	18	18	18	54	114	120
070503420	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503421	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503425	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503432	8	2	10	12	12	12	2	38	12	12	20	0	20	40	100	120
070503502	8	2	10	12	12	12	2	38	12	12	20	0	18	38	98	120
070503503	8	2	10	12	12	12	2	38	12	12	10	0	18	28	88	120
070503505	8	2	10	12	12	12	2	38	12	12	10	0	18	28	88	120
070503506	8	2	10	12	12	12	2	38	12	12	10	0	18	28	88	120
070503507	8	2	10	12	12	12	2	38	12	12	10	0	18	28	88	120
070503508	8	2	10	12	12	12	2	38	12	12	18	18	20	56	116	120
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070503515	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503517	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503523	8	2	10	12	12	12	2	38	12	12	20	20	16	56	116	120
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070503530	8	2	10	12	12	12	2	38	12	12	20	20	10	50	110	120
070503531	8	2	10	12	10	10	0	32	12	12	12	12	8	32	86	120
070503532	8	2	10	12	10	10	0	32	12	12	10	10	6	26	80	120
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070503538	8	2	10	12	10	10	0	32	12	12	0	0	18	18	72	120
070503540	8	2	10	12	10	10	0	32	12	12	10	0	0	10	64	120
070503543	8	2	10	12	10	10	0	32	12	12	0	0	20	20	74	120
070503544	8	2	10	12	10	10	0	32	12	12	4	4	18	26	80	120
070503101	8	2	10	12	10	10	0	32	0	0	4	4	18	26	68	120
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070503108	8	2	10	12	12	12	2	38	12	12	18	20	18	56	116	120
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070503203	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120

070503205	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503210	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503224	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503301	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503413	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503416	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503418	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503433	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503434	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120

070503435	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503436	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503438	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503504	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503516	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503521	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
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070503114	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503115	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503117	8	2	10	12	12	12	0	36	12	12	0	0	20	20	78	120
070503121	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503124	8	2	10	12	12	12	0	36	0	0	0	0	20	20	66	120
070503125	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503126	8	2	10	12	12	12	0	36	0	0	0	0	20	20	66	120
070503129	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503133	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503134	8	2	10	12	12	12	0	36	0	0	0	0	20	20	66	120
070503135	8	2	10	12	12	12	2	38	12	12	0	0	20	20	80	120
070503136	8	2	10	12	12	12	0	36	0	0	0	0	20	20	66	120

070503137	8	2	10	12	12	12	2	38	0	0	0	0	20	20	68	120
070503139	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503140	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
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070503230	8	2	10	12	12	12	0	36	12	12	2	2	0	4	62	120
070503232	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503234	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503240	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
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070503246	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503303	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503307	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
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070503319	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
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070503327	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503328	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503329	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503332	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503333	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503335	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503336	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503341	8	2	10	12	12	12	0	36	12	12	4	4	0	8	66	120
070503343	8	2	10	12	12	12	2	38	0	0	0	0	0	0	48	120
070503344	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503345	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120

070503346	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503410	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503415	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503426	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503428	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503431	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503439	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503440	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503442	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503443	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503444	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503445	8	2	10	12	12	12	2	38	0	0	20	20	20	60	108	120
070503501	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503510	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503513	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503518	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
070503519	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503520	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503522	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503524	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503529	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503532	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503533	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503534	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120
070503536	8	2	10	12	12	12	2	38	0	0	20	20	18	58	106	120

070503538	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503542	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070503545	8	2	10	12	12	12	2	38	12	12	20	20	18	58	118	120
070402545	8	2	10	10	10	12	2	34	12	12	20	20	18	58	114	120
070402530	8	2	10	10	10	12	2	34	12	12	20	20	18	58	114	120
070402613	8	2	10	10	10	12	2	34	12	12	20	20	18	58	114	120
070402636	8	2	10	10	10	12	2	34	12	12	20	20	18	58	114	120
070501402	8	2	10	10	10	12	0	32	12	12	12	12	20	44	98	120
070502108	8	2	10	4	4	12	0	20	12	12	0	0	12	12	54	120
070502114	8	2	10	4	4	12	0	20	12	12	0	0	20	20	62	120
070502117	8	2	10	4	4	12	0	20	12	12	0	0	20	20	62	120
070502126	8	2	10	2	2	12	0	16	12	12	0	0	20	20	58	120
070502133	8	2	10	12	12	12	2	38	12	12	20	20	20	60	120	120
Average score	8	2	10	11.71	11.55	11.82	1.641	36.73	10.23	10.23	15.47	14.98	17.54	47.99	104.9	120

Appendix I: Data of Subjects' Math Score

	The math background of this two groups			
Number	Student ID		math performance	
	Group 1	Group 2	Group 1	Group 2
1	070503102	070503528	79[3]	69
2	070503106	070503539	65	77
3	070503109	070403141	70	69
4	070503111	070503107	76	77
5	070503116	070503110	76	80
6	070503119	070503112	68.5	78
7	070503123	070503113	88	78
8	070503127	070503114	77	78
9	070503130	070503115	76	69
10	070503131	070503117	87	79
11	070503132	070503121	78	74
12	070503138	070503124	80	70
13	070503144	070503125	80	67
14	070503228	070503126	78	63
15	070503236	070503129	89	72
16	070503238	070503133	88	71
17	070503239	070503134	70	82
18	070503242	070503135	62	74
19	070503243	070503136	86	87
20	070503244	070503137	73	77
21	070503246	070503139	77	73
22	070503304	070503140	85	65
23	070503306	070503142	83	73
24	070503312	070503143	75	76
25	070503314	070503201	85	72
26	070503321	070503202	81	74
27	070503322	070503204	81	80
28	070503323	070503207	74	75
29	070503325	070503213	76	74
30	070503334	070503214	85	74
31	070503339	070503216	80	77
32	070503340	070503217	86	63
33	070503344	070503220	70	77
34	070503402	070503221	74	70
35	070503407	070503223	75	84
36	070503409	070503226	79	86

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[3] The full mark of Math exam is 100.

37	070503411	070503227	82	86
38	070503417	070503229	79	77
39	070503420	070503230	84	82
40	070503421	070503232	78	83
41	070503424	070503234	90	78
42	070503425	070503240	87	78
43	070503430	070503243	88	95
44	070503432	070503245	79	73
45	070503502	070503246	76	86
46	070503503	070503303	78	80
47	070503505	070503307	87	72
48	070503506	070503309	76	80
49	070503507	070503310	86	67
50	070503508	070503311	80	65
51	070503509	070503313	82	64
52	070503511	070503315	78	79
53	070503512	070503316	72	82
54	070503514	070503318	86	76
55	070503515	070503319	87	80
56	070503517	070503320	67	88
57	070503523	070503324	74	81
58	070503526	070503326	80	88
59	070503527	070503327	77	70
60	070503530	070503328	84	65
61	070503531	070503329	86	77
62	070503532	070503332	78	73
63	070503533	070503333	80	75
64	070503538	070503335	74	76
65	070503540	070503336	80	73
66	070503543	070503341	60	69
67	070503544	070503343	80	73
68	070503101	070503344	80	74
69	070503103	070503345	77	77
70	070503105	070503346	78	67
71	070503108	070503410	78	75
72	070503109	070503415	72	81
73	070503120	070503426	73	75
74	070503122	070503428	76	69
75	070503128	070503431	85	81
76	070503141	070503439	71	76
77	070503145	070503440	83	68
78	070503146	070503442	77	74
79	070503203	070503443	75	77

80	070503205	070503444	80	76
81	070503209	070503445	78	75
82	070503210	070503501	87	71
83	070503215	070503510	76	79
84	070503219	070503513	77	88
85	070503222	070503518	60	69
86	070503224	070503519	74	79
87	070503225	070503520	66	78
88	070503235	070503522	81	72
89	070503237	070503524	73	76
90	070503301	070503529	78	84
91	070503302	070503532	70	87
92	070503305	070503533	80	65
93	070503308	070503534	60	87
94	070503317	070503536	76	63
95	070503330	070503538	62	68
96	070503337	070503542	61	83
97	070503403	070503545	65	78
98	070503406	070402545	69	81
99	070503413	070402530	76	76
100	070503414	070402613	78	88
101	070503416	070402636	82	74
102	070503418	070501402	70	86
103	070503433	070502108	75	76
104	070503434	070502114	77	75
105	070503435	070502117	87	78
106	070503436	070502126	72	80
107	070503438	070502133	70	88
108	070503504		74	
109	070503516		64	
110	070503521		66	

ANOVA:One factor

SUMMARY

Groups	Count	Sum	Average	Variance		
Group 1	110	8476.5	77.05909	49.51253		
Group 2	107	8149	76.15888	43.04056		
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	43.95484	1	43.95484	0.948904	0.331093	3.885074
Within Groups	9959.165	215	46.3217			
Total	10003.12	216				