THE EFFECT OF JOURNAL WRITING ON FIRST YEAR ENGINEERING STUDENTS' ACHIEVEMENT ON INTEGRAL

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

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ABSTRACT

THE EFFECT OF JOURNAL WRITING ON FIRST YEAR ENGINEERING STUDENTS' ACHIEVEMENT ON INTEGRAL

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This study investigated the effects of journal writing with or without giving feedback and grade, compared to the traditional teaching on integral achievement of students with different learning styles. In addition, students' ideas about the journal writing activities in the mathematics classes were investigated.

The study was carried out with 87 first year engineering students at Atilim University from three classes. Two groups were assigned as experimental groups (EG1 and EG2) and one group was assigned as the control group (CG). Students in all groups received the same instruction on integral. Experimental groups (EG1 and EG2) also engaged in journal writing activities besides lectures. Journal writings of the EG1 students were graded and feedback was given. Journal writings of the EG2 students, however, were not graded and feedback was not given.

Two open-ended achievement tests on integral were developed. One of them was used as pre-test; the other was used as post-test. In addition, Kolb's Learning

Style Inventory was administered as pre-test to determine the learning styles of the students. Follow-up interviews were conducted with ten students from EG1 and EG2. Additionally,

classrooms were observed during the treatment. The results of the ANCOVA suggest that neither the groups' achievement nor the achievement of the students having different learning styles in each group differ significantly on integral. The results of the interviews, however, showed that students found journal writing activities as an effective teaching method and wanted to be engaged in the activity for the future.

Keywords: Journal Writing, Cognitively Oriented Journal Writing, Affectively Oriented Journal Writing, Kolb's Learning Style Inventory.

ÖZ

İRDELEME YAZILARININ BİRİNCİ SINIF MÜHENDİSLİK ÖĞRENCİLERİNİN İNTEGRAL BAŞARILARINA ETKİSİ

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Bu çalışmanın temel amacı, irdeleme yazılarının notlandırma ve geri dönüt verilerek ve verilmeksizin, farklı tip öğrenme stillerine sahip öğrencilerin integral konusunu öğrenmelerindeki başarılarına etkisini geleneksel öğretim metodu ile karşılaştırmaktır. Bunun yanı sıra öğrencilerin irdeleme yazılarının matematik derslerinde kullanılması ile ilgili düşünceleri de araştırılmıştır.

Çalışma, Atılım Üniversitesi'nde öğrenim gören 87 birinci sınıf mühendislik öğrencisi ile yürütülmüştür. Öğrenciler üç ayrı sınıftan seçilmiştir. İki sınıf deney grubu (EG1 ve EG2) olarak, bir sınıf ise kontrol grubu (CG) olarak belirlenmiştir. Tüm gruplar aynı matematik eğitimini almışlardır. Öte taraftan, deney grubundaki öğrenciler dersin yanı sıra irdeleme yazılarını da kullanmışlardır. EG1'deki öğrencilerin irdeleme yazıları notlandırılmış ve geri dönüt verilmiş, EG2'deki öğrencilerin irdeleme yazıları notlandırılmamış ve geri dönüt verilmemiştir.

İntegral konusu ile ilgili iki başarı testi geliştirilmiştir. Bu testler açık uçlu sorulardan oluşmaktadır. Testlerden biri ön-test, diğeri ise son-test olarak uygulanmıştır. Bunların yanı sıra Kolb'un Öğrenme Stil Envanteri öğrencilerin öğrenme stillerini belirlemek üzere ön-test

olarak verilmiştir. Uygulama bitiminde Deney Grubu1 (EG1) ve deney Grubu2 (EG2) den toplam on öğrenci ile görüşmeler yapılmıştır. Ayrıca, çalışma sırasında sınıflar gözlemlenmiştir.

ANCOVA'nın sonuçları, integral konusunda gruplar arasında ve aynı grupta bulunan farklı öğrenme stiline sahip öğrenciler arasında önemli bir fark olmadığını göstermektedir. Öte taraftan, öğrencilerle yapılan görüşmelerin sonuçları, öğrencilerin irdeleme yazılarını etkili bir öğretme tekniği olarak değerlendirdiklerini ve gelecekte de bu aktiviteye devam etmek istediklerini göstermektedir.

Anahtar Sözcükler: İrdeleme Yazıları, Bilişsel Tabanlı İrdeleme Yazıları, Duygusal Tabanlı İrdeleme Yazıları, Kolb'un Öğrenme Stil Envanteri

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LIST OF ABREVIATIONS

EG1	: Experimental Group 1
EG2	: Experimental Group 2
CG	: Control Group
N	: Sample Size
SS	: Sum of Squares
MS	: Mean Square
F	: F Statistics
P	: Significance Value
η^2	: Significance Level

CHAPTER I

INTRODUCTION

The main goal at every level of today's education is to provide students with an operative knowledge, and key competencies, which will create a basis for further learning-according to actual social and professional demands and potentialities. Current viewpoints on general education indicate a clear shift emphasis in social expectations towards the educational aims: developing creativity and cognitive abilities instead of mastering simple skills, which are useful only in typical situations (Lakoma, 2002). Mathematics is one of the most important tools serving the objectives of the education as being an operating tool in learning, like the surgeon's scalpel, and allowing us to penetrate into the inner characteristics of phenomena (Gnedonko and Khalil, 1979).

Calculus is an important subject area within mathematics as being one of the three cornerstones of modern mathematics (Stewart, 1975; Orton, 1983). Golden (2003) states that the development of calculus is one of the greatest intellectual achievements of the past two millennia. Calculus provides the language and basic concepts used to formulate most of the fundamental laws and principles of the various disciplines throughout the physical, mathematical, biological, economic and social sciences, as well as electrical, mechanical, computer, civil, and materials engineering. Without calculus, most of the developments in science and engineering which occurred in the twentieth century and have become essential part of our everyday life, such as air travel, television, computers, weather prediction, medical imagining, wireless phones, the internet, etc. could not have happened (Golden, 2003). Although calculus is very important in our life, it is not easy for students to learn it (Keith, 1989; Orton, 1980; Ubuz, 1996).

The fundamental topics of calculus-functions, limit-continuity, derivative, and integral, all are hard for students to comprehend (Rasslan and Tall, 2002; Tall, 1993). Nevertheless, integral is one of the most difficult topics to learn (Rasslan and Tall, 2002). While students are learning the topics other than integral, they obtain the result by using a flow of rules. However, in the learning process of integral the rules are stable. In order to get the result, students should make these rules dynamic by using their experience obtained by the pre-given rules of integral. For instance, when a student learns the substitution method, he/she basically learns as a rule that when the differential of an appropriate function which is chosen by the student is substituted in the integral, it gives the whole integrand or a part of it. Therefore, he/she can handle the simplified integral which can be evaluated by using the pre-given stable rules of integral concept.

Many activities have been conducted in teaching and learning of mathematics. Journal writing is the one which has been focused the recent years. Countryman (1992) states that knowing mathematics is doing mathematics. Students need to be active, creative and responsive to the physical world. In order to learn mathematics, students must construct it for themselves by exploring, justifying, representing, discussing, using, describing, investigating, predicting, in short being active in the world. Writing is an ideal activity for such processes (Countryman, 1992). Writing in mathematics provides opportunities for students to construct their own knowledge of mathematics. It allows students to explore and organize the mathematics presented in their own terms; it allows for invention, and it facilitates both learning and retention (Keith, 1989). Brandau (1989) supports this by stating that writing is central to understanding process, since we often do not know what we think until we need to find the words put to paper.

The use of student writing activities as a part of mathematical learning has been the focus of much research. Although there are some studies indicating that writing in mathematics has a positive effect on understanding (Countryman, 1992; Jurdak and Zein, 1998), there are also studies showed that journal writing has no effect on learning mathematics (Croxton and Berger; Porter and Masingila, 2000). In addition, there is also no consensus on whether the journal writings graded and given

feedback (Countryman, 1992; Math Journals, 2003; Miller, 1992). For example, Hartz (1989) states that students should not be penalized by grading their work. On the other hand, Marvine (1989) reports that many students equate being graded with being taken seriously and desiring to work only when they can receive a grade.

Individual differences have been seen to play an important role in students' successes and failures. Determining how individuals learn may be one of the focus points of a research. Because of that, before implementing a new technique or activity, it would be better to find out the learning styles, which are the individual's characteristic way of processing information, feeling and behaving in learning situations, of students (Andrew, Green, Holley and Pheiffer, 2002).

The main purpose of this study was to answer the following research questions:

- Is there a significant difference in the performance scores of students on integral that can be attributed to: (i) treatment, (ii) learning style, and (iii) interaction of treatment and learning style?
- What are the students' opinions about the journal writing activities?
- What are the students' opinions about grading and feedback?
- What are the students' difficulties related to integral?
- What are the students' views about the components of treatment (teachers, quizzes, homeworks, recitation hours etc.)?

CHAPTER II

REVIEW OF LITERATURE

2.1 Calculus and Its Importance

Calculus is simply defined as the mathematical study of change and rates of change (Golden,2003 ; Kasner and Newman, 1949). Calculus is naturally divided into two halves: differentiation-the study of rate of change, and integration-the study of total change (Golden, 2003). Differential calculus includes the study of derivative. Integral calculus deals with the question how to find the total area under the graph of a function on an interval [a, b] (Golden, 2003).

The importance of calculus is stated in different perspectives: the importance of calculus for mathematics and the importance of calculus for life. Barnes (1992) stated the importance of calculus for mathematics as follows:

> Calculus can help students to appreciate the power of mathematics and its use in helping us to understand the changing world we live in, to predict outcomes and in some cases to control them. By becoming confident in mathematics at this level, students may be encouraged to question its use by so-called "experts" who use mathematics as propaganda to support their side of an argument. So, I think that teaching calculus to this group can be justified as a part of education for the whole of life, rather than solely as a preparation for career or further study. Ultimately, an understanding of the power of mathematics is important, not just for those who will use it in their work, but for those who make policy decisions and, ultimately, for all citizens (p.73).

Also, Ferrini-Mundy and Lauten (1994) stated:

> Calculus is a critical landmark in the mathematical preparation of students intending to pursue nearly all areas of science and, increasingly, the social sciences (p.120)

In addition to these, (Golden, 2003) argued that calculus, within mathematics, serves as the inescapable gateway to all higher level courses. Golden also stated the importance of calculus in life as follows:

> It can be said that the development of calculus is certainly one of the greatest intellectual achievements of the past two millennia. Without calculus, most of the incredible advances in science and engineering which occurred in twentieth century have become part of everyday life, such as air and space travel, television, computers, weather prediction, medical imagining, nuclear bombs, wireless phones, the internet, microwave ovens, etc., could not have happened (p.1).

It can be concluded from above discussions that calculus is an indispensable part of mathematics and essential tool used widely throughout business and industry such as in the financial, insurance, transportation, manufacturing, and pharmaceutical industries, and in the development of computer communications, and medical technologies which constitute the main parts of our life (Golden, 2003).

2.2 Journal Writing and Its Importance

> In all other disciplines, some writing-term papers, book reviews, lab reports, etc.-is required. Is mathematics really so special? I do not think so. We have simply neglected an important part of our students' education. We pay the penalty in frustration when we find our math majors practically illiterate in the language of mathematics. Can you imagine students who have taken eight years of French and still can not write or speak a simple sentence? If my students parachuted into Algebraland, most of them would starve because they could not speak the language. (Price, 1989, p.2)

Journal writing, which involves a regular series of writing episodes kept together in some form, normally invites students to reflect on their learning by expressing their thoughts and feelings about the mathematics they are learning (Nahrgang and Peterson, 1986). As the students engage in the writing process, mental structuring or restructuring of the mathematics occurs and the student comes to "own" the topic or idea (Sharp, 1998). These offer the possibility for the students to develop

a deeper understanding of the mathematics they have been learning and for the teachers to enlighten the learning that is going on (Borasi and Rose, 1989; Geeslin, 1977; Miller, 1992; Schmit, 1985). Besides, teachers also benefit from journal writing which include better evaluation and remediation of individual students, as well as improved teacher reflection on teaching (Jurdak and Zein, 1998).

Students have always spent much time in the act of writing during the mathematics lessons. However, this writing has generally involved little more than the learnt symbolic processes, which tend to dominate mathematics learning (Applebee, 1984; Baroody and Ginsburg, 1990). On the other hand, journal writings are offered to students to communicate about mathematics either cognitively or affectively (Bagley and Gallenberger, 1992; Borasi and Rose, 1989; Chapman, 1996; McIntosh, 1991; Pugalee, 1997; Stewart and Chance, 1995). Geeslin (1977) indicated that most of the students can repeat a text book definition such as "an event is a set of outcomes" but when asked to explain how these two concepts are related or to write a sentence containing both words, students almost never write the definition or any mathematically correct statement. In order to qualify the writing activities as a tool for learning what we should want from the students is just to write their own definitions or explanations of terms being learned in the mathematics, which is named as cognitively oriented journal writings (Schmit, 1985). These writings give them a chance to practice inferring, communicating, symbolizing, organizing, interpreting, linking, explaining, planning, reflecting and acting. Writing helps students make sense of mathematics. Mathematics helps students make sense of the world.

Borasi and Rose (1989) asserted that affectively oriented journal writings in mathematics teaching have therapeutic effect on the feelings and attitudes of students. Because students often write about problems that they would not have talked about otherwise, a new line of communication was created between student and teacher (Stewart and Chance, 1995). Besides, the affective views encourage teachers to assess their teaching methods and classroom practice (Williams and Wynne, 2000).

As a result, learning in math class depends on communication and writing mainly a way of opening lines of communication. So, writing is an indispensable part of learning mathematics (Schmit, 1985).

2.3 How to Adopt and Use Journal Writing in the Class

How journal writing is used in class depends on the purposes and preferences of the researcher and/or instructor and the particular needs of the students. It is generally used in three ways (Burns and Silbey, 1999). First, in some classes, students do all their work in their journals, using them daily during lessons to keep notes and do problems. Second, students write their journal writings at the end of math class, describing what they did and what they learned, including things they are not sure about, or questions they have. Third, students are given a problem to do or a question on which to reflect their ideas to be completed outside of the class.

Students are introduced journals in some different ways. One of them is having an information sheet (or, a written hand out) and/or a brief oral explanation of the rationale for journals (Borasi and Rose, 1989; Jurdak and Zein, 1998; McIntosh, 1991; Talman, 1990). The information sheet describes in some detail what instructor expected from students to do with their journals (Talman, 1990). For example, Williams and Wynne (2000) used a syllabus, presented in Table 2.1, included the purpose of journals, materials that students needed, the procedures, the expected format and grading criteria.

Table 2.1: Syllabus for journal writings

PURPOSE

Journal entries are an integral part of a mathematics class for three main reasons:

1. Journal entries tend to enhance a person's learning of a concept because he or she is taking an active part by conveying knowledge instead of just absorbing the material and working set of problems.
2. The student receives individual feedback from the teacher in writing; the feedback may clear up any misunderstanding about the topic at hand.
3. The teacher is able to get an idea of a student's thought processes, as well as address any concerns that the students may have.

MATERIALS

Although, I am not requiring that you purchase a second notebook for journal entries, I do strongly urge you to set up a separate section in your current math notebook so that you can access your journals easily-especially on due dates!

GRADING

You must include the following information for every journal entry: the topic (or tile) and topic number, current date, your name, and class period. In addition, you should write neatly and legibly in blue or black ink. Pencils are acceptable; however, pencils tend to rub off onto other pages. Although my main concerns is mathematics, good grammar and appropriate vocabulary is a must! Furthermore, each journal entry should approximately one page in length. Points for journal entries are earned not deducted, and to ensure fair grading of journals, I am including the following grading rubric:

Criteria	Maximum Point Value
Name, date, title, class period	10
Neatness	10
Vocabulary and grammar	10
Appropriate length (approx. 1 page)	20
Mathematical content	50

You should plan on one journal entry per week. These journal entries will be collected every week. No late journal will be accepted. You will find the day's topic on the chalkboard, and you should begin in your journal as soon as you enter the classroom.

Writing about thinking is challenging. Because of that, it is best not to start out having students write about unfamiliar mathematical ideas. In order to get students used to writing in a math class, beginning with affective, open-ended questions about students' feelings would be better. For instance, students can be asked to describe how they feel about solving an integral question. Once the students have become accustomed to writing about their attitudes and feelings toward mathematics, they are ready to write about simple, familiar math concepts. When instructor/researcher feels that students are ready, they are asked to write about more complex mathematical ideas (Journaling, 2001). While students should maintain a high degree of freedom about what they write in their journals, they should also be encouraged to include entries which go beyond the recording of events and personal thoughts-for example, reflections on material learned in class, reactions to readings or lectures, or even responses to open ended assignments (Borasi and Rose, 1989). For example, "Discuss: Factoring and finding a product are reverse processes" (Nahrang and Peterson, 1986).

Journal writing prompts are provided by the teacher given on a piece of paper with space for the writing, or presented on the chalkboard or on the overhead projector (Bagley and Gallenberger, 1992; Borasi and Rose, 1989; Burns and Silbey, 2001; Chapman, 1996; Jurdak and Zein, 1998; Masingila and Porter, 2001; Mastin, 1996; Miller, 1992; Moss, Sovchik and Dipillo, 1997; Shield and Galbarith, 1998; Stewart and Chance, 1995; Williams and Wynne, 2000). The prompts can be put into two different categories. First one is cognitively oriented prompts –some researcher call them expository writing (Ninomiya, 2000; Shield and Galbraith, 1998)-, which are focusing on the mathematics learning, concepts and procedures (Bagley and Gallenberger, 1992; Chapman, 1996; Jurdak and Zein, 1998; Masingila and Porter, 2001; Miller, 1992; Ninomiya, 2000; Stewart and Chance, 1995; Williams and Wynne, 2000). For example, "Imagine you have a friend, who was absent today. You call him, and you do a summary of today's math lesson, assuming that your friend will rely on you and your explanation. So be as clear as possible, and do not miss any important point that was mentioned" (Jurdak and Zein, 1998, p.415), "Explain the angle-side relationship of triangles. Describe two types of questions that could be asked on a test" (Williams and Wynne, 2000), "Do 0.2 and 0.020 equal the same fraction? Explain your answer" (Journaling, 2001) or "Subtracting is the same as

adding the opposite because ….." (Stewart and Chance, 1995, p.92). Second one is affectively oriented prompts –some researchers called this category as free writing (Stewart and Chance, 1995)-, which are directing students to express their goals, strategies, reactions, accomplishments, positive and negative feelings, frustrations and suggestions for improving teaching (Chapman, 1996; Jurdak and Zein, 1998; Masingila and Porter, 2000; Williams and Wynnne, 2000). For instance, "Explain how you feel about mathematics now as compared to before you took this class" Math Journals, 2001) "List all the mistakes you have made on homework problems, in class discussions, and exams. Do these errors have anything in common? Can you categorize them? How do you think you can learn from them? What do your particular errors tell you about the way you approach a problem?" (Kenney, 1989) or "Discuss (in paragraph form) three qualities of a good teacher and three qualities of a good student, explain why these qualities are important" (Williams and Wynnne, 2000).

The timing of journal writing varies depending on its role in day's lesson since it is an excellent warm up for a new topic as well as a quick assessment of learning at the end of the class (Chapman, 1996). In addition to this, journal writing becomes an excellent tool for evaluating conceptual understanding when spontaneous opportunities arise in the middle of the class (Math Journals, 2001). The journals were usually given in class activities but since time was limited sometimes either some part of it was completed at home or it was given to be completed outside of the class (Masingila and Porter, 2001; Talman, 1990; Williams and Wynne, 2000).

2.4 Advantages and Disadvantages of Journal Writing

Journal writing is a new method in teaching of mathematics. As all the methods, it has both advantages and disadvantages which are mentioned by many researchers (Bagley and Gallenberger, 1992; Chapman, 1996; Jurdak and Zein, 1998; Liebars, 1997; McIntosh, 1991; Miller, 1992; Watson, 1980).

2.4.1 Advantages

The advantages of writing in mathematics could be divided into three general categories: (i) advantages for the student as writer, (ii) advantages for the teacher as reader, and (iii) advantages for the student-teacher interaction (Rose, 1989).

2.4.1.1 Advantages for the Students

Several authors posited that the keeping of a journal has many benefits for the writer (Borasi and Rose, 1989). These benefits can be divided into five different categories: (a) opportunities to express their feelings, (b) better retention of information, (c) increased understanding of mathematics, (d) stimulation of thinking about mathematics, and (e) improved writing they had learned (Moss, Sovchik and Dipillo, 1997).

A great majority of the students' entries deal with feelings and attitudes towards mathematics and its learning (Borasi and Rose, 1989). Students communicate about their strengths, fears, weaknesses, and beliefs (Countryman, 1992). These make students participate by communicating ideas, questions or suggestions when they are too shy or intimidated to do so in front of the entire class (Bagley and Gallenberger, 1992). Expressing their apprehensions about mathematics, reporting past experiences of failure or success, and communicating feelings of incompetence or discomfort about the course could help the journal writers learn about themselves and take steps towards overcoming their perceived difficulties (Borasi and Rose, 1989). Some students reported the therapeutic value of journal writing as follows:

> It helps me to get my feelings out more than speaking, because it's hard for me to talk to people sometimes…it brings out what you sometimes keep inward (Rose, 1989, p.65).

> …helped me calm down. Writing made the course relaxing and easier to bear (Rose, 1989, p.65).

> To talk about journal writing, well it takes the pressure off because you acknowledge that you can not answer it. That you can not do it, and then you can ask whatever you want to ask without feeling… stupid (Rose, 1989, p.65).

Most of the focused in class writing assignments concerned specific mathematical content being currently covered, so the students were forced to write about specific concepts (Rose, 1989). These writings offer an interactive way for students to communicate back what they have learned, so that teaching is not a one way street. They encourage students to sort out logically, construct, and make

concepts meaningful for themselves. Initially, the writings serve to help students sort the prior information themselves; later, they are able to communicate those ideas to others (Stix, 1994). So, the students summarize, organize, relate and associate prior knowledge, which cause a better retention of mathematics (Bagley and Gallenberger, 1992; Moss, Sovchik and Dipillo, 1997).

The writing assignments concerned specific mathematical content being currently covered has also another benefit for the students: It increases understanding of mathematics. Journals allow students to work at their own rate and to reach an understanding of mathematical concepts by using their own experiences (Pugalee, 1997). Restating concepts and rules in one's own words can in fact facilitate their internalization. Students can no longer be content to manipulate symbols successfully- they have to create their own meaning for symbols in order to express them in words on paper (Borasi and Rose, 1992). So, the students construct a very individualized meaning, like an "inside joke" or a personal translation which make them understand mathematics better and detect what is understood and what problem areas still remain (Rose, 1989).

The standardized curriculum expects students to do mathematics, not to think about its nature or raise questions about its existence. Journal writings however, enlarge students' views of both the content and methodology of mathematics. They enable students to see mathematics as more than crunching and single "right" ways to solve problems (Rose, 1989).

Lastly, besides many benefits of journal writing in mathematics mentioned above, they also improve the students' writing abilities (Countryman, 1992; Sipka, 1989)

2.4.1.2 Advantages for the Teachers

When the students write, the teachers profit from them in many respects (Rose, 1989). Through the use of journals, a teacher can gain some insight into the "person" who is their student (Math Journals, 2001) Chapman (1992) found that journals revealed abilities and mathematical awareness that had been hidden by low grades. Gordon and MacInnis (1993) indicated that personal feelings and emotions were readily explored and expressed as trusting and personal relationships were built in the journal communication. Using journal is also a realistic way of listening to

each student individually (Math Journals, 2001). Teachers can also learn more about the effectiveness of the instructional strategies they utilize if they ask students to evaluate their teaching techniques (Math Journals, 2001). In addition to these, Chapman (1996) found journals extremely useful for diagnosing misconceptions. Lastly, journal writings allow teachers an alternative way to review and analyze students' thinking, reasoning and learning styles (Bagley and Gallenberger, 1992; Moss, Sovchik, and Dipillo, 1997; Stix, 1994).

2.4.1.3 Advantages for the Student-Teacher Interaction

When students write entries and the teacher reads and responds to them, a new mode of communication is created in the classroom- a private dialogue between the teacher and each student. Not only can teachers and students learn more about each other and interact more personally in this way, but a different rapport between them can be established, with positive benefits for both parties (Borasi and Rose, 1992; Countryman, 1992; Croxton and Berger, 2003). As a result of better communication, several additional benefits were reported by Rose (1989). She stated that writing in classroom allowed the teachers to give better feedback and students to feel more comfortable with the teacher and the course. As the students feel more comfortable, their motivation and attention to the course increases (Borasi and Rose, 1992; Rose, 1989). So, a better class atmosphere is created (Bagley and Gallenberger, 1992; Borasi and Rose, 1992).

2.4.2 Disadvantages

The major disadvantage of using journal entries has to do with grading them. First, grading journal entries is time consuming (Chapman, 1992; Croxton and Berger, 2003; Silver, 1999; Talman, 1990). However, Countryman (1992) addresses this concern with simple methods, such as a simple grading system divided into competent, satisfactory and inadequate groupings, through which writing can be incorporated into the classroom without resulting in an overload of work for the teacher. The second disadvantage associated with grading journals is that as mathematicians, we are likely to be uncomfortable with the idea of grading writing because grading of writing seems more subjective than grading of mathematics (Talman, 1990).

2.5 Evaluation of Journal Writing

Journal writings are used as an alternative form of assessment, such as daily grades, active-participation grade or some percentage of the final grade (Chapman, 1996; Liebars, 1997; Mayer and Hillman, 1996; McIntosh, 1991; Nahrang and Peterson, 1986; Talman, 1990). If journals are to be evaluated, the teacher needs to be clear on what is expected, since it would be unfair to grade journals without first explaining to the students the process and expectations. Before grading, modeling responses might be helpful for the students to clarify any ambiguous points. By this way, those who have been successful with the traditional methods are challenged in a new way, and those who have not, are given the opportunity to succeed in different venue (Mayer and Hillman, 1996).

Talman (1990) states that evaluation of journal entries should not depend on the correctness of the mathematics included. The vital thing in the evaluation process is the effort that a student puts into thinking about mathematics, into thinking about thinking about mathematics, and into organizing those thoughts for presentation in writing. But this does not mean to let incorrect mathematics slip by uncorrected. The students should be commented on their writings without penalizing them. For example, a mistake was made in calculating the derivative, so that the second critical point was not found (Talman, 1990).

Stix (1994) on the other hand suggests a format for evaluating students' journals beginning with an assessment of a student's flow of thoughts: how often he/she employed words, pictures, and numbers at each step of his or her discovery process. Next, using a scale of 1 through 5 (for ratings of nonexistent, marginal, adequate, above average, and excellent), the teacher rates the student's handling of the central ideas of the lesson: first, whether the student offers logical evidence to support his/her major points; second, whether he/she manipulates diagrams approximately, using good spatial sense; third, how he/she coordinates pictures, words, or numbers for each step; and fourth, whether he/she exhibits an overall level of understanding.

Williams and Wynne (2000) proposes an evaluation in which half of the grade was accounted for the content of the entry and the other half of the grade was accounted for the effort. For the grade effort, 10 percent of the grade was for

neatness, 10 percent for vocabulary and grammar, 10 percent for the headings, and 20 percent for length.

2.5.1 To Grade or Not to Grade Journal Writings

Grading serves many purposes. It helps students to improve their performance and provide information to the student and others regarding the teacher's professional opinion of the potential of the student as the content and skills being studied (Wager, 2002). However, Countryman (1992) states that the journal writings should not be graded although the students should receive credit for their work. Similarly, Hartz (1989) mentioned that the aim of the journal writing is making students struggle to express their understanding in their own words so the students should not be penalized by grading their work. On the other hand, Marvine (1989) reports, "telling students that you will read and respond to what they write but will not grade it is not enough because many students equate being graded with being taken seriously, desiring to work only when they can receive a grade" (p.62). To some, a task ungraded is often unheeded (Math Journals, 2001). Chapman (1992) who states that the journal writings should not be graded however, found that by raising expectations and the point value of the journals, more students became actively engaged in the quality of the journal as a means of communication (Math Journals, 2001).

2.5.2 To Give or Not To Give Feedback

> When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection's strength is increased. When made and accompanied or followed by an annoying state of affairs, its strength is decreased (Thorndike, 1913, p.4)

Feedback is essential to mutual influence. Since learning is often a process of mutual influence, feedback is an essential part of learning (Bangert-Drowns, Kulik, Kulik and Morgan, 1991). Feedback can promote learning if it is received mindfully, but it can inhibit learning if it encourages mindlessness (Salomon and Globerson, 1987).

The most important instructional effect of feedback would be to correct erroneous responses, not to strengthen correct responses (Bangert-Drowns, Kulik, Kulik and Morgan, 1991). Feedback provides this by singling out key errors and offering corrective errors. These procedures foster students' expectations for success in future work and promote positive performance outcomes (Elewar and Corno, 1985). The error-correcting action of feedback is more effective when it follows a response about which the student felt relatively certain. Because when students discovered that a "sure" answer was actually incorrect, they were more likely to study the feedback than if they had originally been uncertain of their answer (Kulhavy and Stock, 1989). In addition to this, it should be pointed out that the delay of the feedback increases the effectiveness of feedback (Bangert-Drowns, Kulik, Kulik and Morgan, 1991).

Feedback can inhibit learning if it is given before students construct their own answers to questions. As students could simply copy feedbacks answers and, therefore, not study the material at all (Bangert-Drowns, Kulik, Kulik and Morgan, 1991). Because of that presearch availability should be controlled.

Feedback is also an important part of writing activities. Gordon and MacInnis (1993) state that one of the driving forces for the students' writing appeared to be their keen interest in the teacher's response and the need to maintain that communicative bond. Nahrgang and Petersen (1986), Gordon and MacInnis (1993) and Scott, Williams and Hyslip (1992) agree that teachers' responses to their students' journal writings is vital to the success of journal writing in mathematics class.

Teachers' responses need to be regular and sincere, but not judgmental or evaluative (Gordon and MacInnis, 1993). The responses could be in the form of questions, comments, or notes of encouragement (e.g. "excellent", "good", "incomplete", or "please revise"). Mathematical concepts should not be tried to teach through written comments. In these comments, students should be informed that their misconceptions or concerns have been noted and will be addressed. Mayer and Hillman (1996) added to these that the comments should include constructivist criticism to focus the students' attention on effective writing for communicating mathematics.

While the majority of the teachers make written comments, some teachers choose not to respond in writing but to speak to individual students privately (Ref.18). While talking the results orally, students should never be singled out in front of the class since a set of journal entries may necessitate a response to the whole class (Miller, 1992).

2.6 Kolb's Learning Style Inventory

Since people are unique and learning in adulthood is characteristically controlled by the previously sighted assumptions, individual differences in learning comes out which brings us the topic learning styles (Strawbridge, 2003). Although the existence of individual differences is quite spread and accepted, the educational researchers define learning styles differently: Gregorc (1979)emphasizes different behaviors and dualities as indicators of how the person learns and adapts to the environment; Dunn and Dunn (1979) relate incentives and elements (environmental, emotional, sociological and physical) and Schmeck (1982) conceives learning styles as a strategy, examining it on the basis of individual actively processing information while involved in the learning task. In agreement with Dunn (1981), for Kolb the learning style is the result of hereditary equipment, past experience, and demands of the present environment combining to produce individual orientations that give differential emphasis to the four basic learning modes postulated in experiential learning theory: Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) (Kuri, 1998).

In the Concrete Experience (CE) or "feeling", the learner tries to integrate new information to his own values and feelings (Kuri, 1998). He tends to rely on feeling based judgments (Lecture notes, 2000). The personal involvement is emphasized and the learning happens based on specific experiences, personal relationship and sensibility to the values and personal feelings (Kuri, 1998).

In the Reflective Observation (RO) or "watching", the learner views issues different point of views. He discovers meaning in the learning material (Cooper, 2004). He tends to be patient, objective and careful in the judgment, but he does not necessarily take any decision. His approaches to learning is tentative, impartial and reflective (Lecture notes, 2000). He trusts in his own thoughts and feelings to form

opinions. The learning is characterized by the careful observation and thinking before doing judgments (Kuri, 1998).

In Abstract Conceptualization (AC) or "thinking", the learner approaches to learning analytically and conceptually. He relies heavily on logical thinking and rational evaluation (Lecture notes, 2000). He tends to leave its personal opinions sideway and to obtain a universal description or general principle. The logical analysis of the ideas, the systematic planning and the intellectual understanding of the situation characterize the learning in this apprenticeship (Kuri, 1998).

In the Active Experimentation (AC) or "doing", the learner wraps up directly with the situation to test the ideas. He tends to apply the material learned in new situations to solve real problems (Kuri, 1998). He thinks about how the information offers new ways for us to act (Lecture notes, 2000). This learner type has ability to test theories, carry out plans, and influence people and events through activity (Cooper, 2004).

Learning styles of the individuals are the combination of the learning modes described above (Kolb, 1985). As the combination of learning modes, Kolb (1985) identified four learning styles based on whether learners are active or reflective information processors and whether their understanding are based on concrete or abstract perceptions; the four styles are: Diverging, Assimilating, Converging, and Accomodating (Kolb, 1985).

Diverging: The Diverging style's dominant learning abilities are Concrete Experience (CE) and Reflective Observation (RO). People with this learning style are best at viewing concrete situations from many different points of view (Kolb, Boyatzis and Mainemelis, 2000). They are creative, efficient to generate alternatives, to identify problems and to understand people (Kuri, 1998). They prefer to work in groups, listening with an open mind and receiving personalized feedback (Kolb, Boyatzis and Mainemelis, 2000). They try to know the value of what they will learn and their favorite subject is the question "Why?" (Why is important to know this concept?) (Kuri, 1998). Generally, people from humanities and liberal arts belong to this group (Lecture Notes, 2000; Aşkar and Akkoyunlu, 1993).

Assimilating: The Assimilating style's dominant learning abilities are Abstract Conceptualization (AC) and Reflective Observation (RO). People with this learning

style are best at understanding a wide range of information and putting into concise, logical form (Kolb, Boyatzis and Mainemelis, 2000).They work very well with a great variety of information, placing them in logical order. They are generally more interested in the logic of an idea than its practical value (Kuri, 1998). The Assimilating learning style is important for effectiveness in information and science careers. People with this learning style prefer readings, lectures, exploring analytical models, and having time to think things through (Kolb, Boyatzis and Mainemelis, 2000). Their favorite subject is the question "What" ("what do I need to know to solve this problem") (Kuri, 1998). Generally, theorists and researchers belong to this group (Lecture notes, 2000; Aşkar and Akkoyunlu, 1993).

Converging: The Converging style's dominant learning abilities are Abstract Conceptualization (AC) and Active Experiment (AE). People with this learning style are best at finding practical uses for ideas and theories (Kolb, Boyatzis and Mainemelis, 2000). They appreciate to do practical applications of ideas and theories, they have good acting in the conventional tests, they use the deductive reasoning and they are good to identify and solve problems and to take decisions (Kuri, 1998). They prefer to deal with technical tasks and problems rather than with social issues and interpersonal issues. These learning skills are important for effectiveness in specialist and technology careers (Kolb, Boyatzis and Mainemelis, 2000). Their favorite question is the subject "How" ("how can I solve this problem?") (Kuri, 1998). Generally, people specializing in physical sciences such as engineers belong to this group (Lecture notes, 2000; Aşkar and Akkoyunlu, 1993).

Accommodating: The Accommodating style's dominant learning abilities are Concrete Experience (CE) and Active Experimentation (AE). People with this learning style have the ability to learn from primarily "hand-on" experience. They enjoy carrying out plans and involving themselves in new and challenging experiences (Kolb, Boyatzis and Mainemelis, 2000). They adopt well to immediate circumstances, they learn placing the "hands-on" and facing risks (Kuri, 1998). This learning style is important for effectiveness in action-oriented careers such as marketing or sales. Accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project (Kolb, Boyatzis and Mainemelis, 2000). Their favorite

question is the subject “What if?” (“What if I do something different to solve this problem?) (Kuri, 1998). Generally, people working in marketing and sales belong to this group (Lecture notes; Aşkar and Akkoyunlu, 1993).

CHAPTER III

RESEARCH DESIGN AND METHOD

This chapter presents the framework of the study; defining sample and instruments; describing the method of the data collection and analysis; explaining the treatments for the experimental and control groups; stating the scoring criteria for the questions in the instruments and journal writings and the limitations of the study.

3.1 Sample

A total of 163 1st year university students whose ages ranged from 17-26 with a mean 20 and majoring in computer, civil, industrial, mechatronics and, electrical and electronics engineering from three classes at Atilim University which is an English medium university, formed the sample of this study. One of the three groups constituted the control group (CG) while two of the groups constituted the experimental groups (EG1, EG2). CG consisted of six females and 21 males; EG1 consisted of seven females and 25 males; EG2 consisted of one female and 27 males. The students who took both pre-test and post-test were taken as the subject of the study. The number of students who took both pre-test and post-test is given in Table 3.1.

Table 3.1: The Subjects of the study

Groups	Pre-Test	Post-Test	Pre-Test ∩ Post-test
Experimental Group 1	49	37	32
Experimental Group 2	41	36	28
Control Group	39	29	27
Total Groups	129	102	87

3.2 Instruments

. **3.2.1 Pre-Test**

Pre-test including essay type questions (See Appendix A) was developed to investigate the students' prior knowledge about the definition of integral concept, integration techniques and, area and volume applications of integrals. The test consisted of four questions but one of which had four sub items. The test consisted of seven questions altogether. The objectives of each question in pre-test are given in Table 3.2. The questions and their objectives were checked by an expert on mathematics education to determine the extent to which the questions provide a relevant and adequate representative sample for the high school curriculum.

Table 3.2: Objectives of each question in the pre-test

Question	Objectives
1	To produce a correct definition of "integral".
2(a)	To apply the power rule to evaluate an integral.
2(b)	To apply the substitution rule to evaluate an integral. To apply the power rule to evaluate an integral.
2(c)	To apply the substitution rule to evaluate an integral. To know the integral of $\frac{1}{x}$.
2(d)	To apply the integration by parts technique to evaluate an integral.
3	To find the area under a given curve.
4	To find the volume of a solid generated by rotating the area bounded by $y = -x + 1, x = 0$ and $y = 0$ about the x-axis.

3.2.2 Post-Test

Post-test including essay type questions (See Appendix B) was developed to investigate the students' understanding of the antiderivative and indefinite integral concepts, integration techniques, Mean Value and Fundamental Theorems for integrals, the arclength, area and volume applications of integrals, the properties of

integrals and the integrand variable. The test consisted of seven questions to be answered by providing written responses. The objectives of each question in the post-test are given in Table 3.3. The questions and their objectives were checked by the instructors of the course and an expert in mathematics education to determine the extent to which the questions provide a relevant and adequate representative sample for the content of the course.

Table 3.3: Objectives of each question in the post-test

Question	Objectives
1	To find the value of the derivative of a function including a polynomial and an antiderivative at a specific point.
2	To distinguish the antiderivative and indefinite integral.
3	To comprehend the meaning of antiderivative. To generate an exemplar related with antiderivative.
4	To identify the correct form(s) of the symbolic representation of the area under a curve. To explain the reasons of the choices to be correct.
5	To define how to find the length of a curve which is the graph of a smooth function over a closed interval. To generate an exemplar related with finding the length of a smooth curve over a closed curve.
6	To state the integral formula for the volume of a solid generated by revolving a given region between two curves about the x-axis by using Washer method. To state the integral formula for the volume of a solid generated by revolving a region between two curves about the x-axis by using Cylindrical Shell method. To examine which method is better to find the volume.
7	To comprehend the properties of definite integral (order of integration rule, additivity rule, product rule and constant multiple rule). To comprehend the integral variable concept.

3.2.3 Learning Style Inventory

A Likert type learning style inventory developed by Kolb (1985) and translated by Aşkar and Akkoyunlu (1993) to Turkish was used as a pre-test to determine the learning styles of the students (See Appendix C). The inventory consisted of 12 statements. There were four possible alternatives for each statement: The most suitable situation for me, the second suitable situation for me, the third suitable situation for me and the last suitable situation for me. Grades of the alternatives were 4, 3, 2 and 1 respectively. First alternative refers to concrete experience (CE), second one refers to reflective observation (RO), third one refers to abstract conceptualization (AC) and the fourth one refers to active experimentation (AE). So, every alternative gets a score between 12 and 48 according to the students' responses. At the end, the score of each expression is determined and then the combined scores are evaluated (AE-RO and CE-AC). The intersection of these two combined scores on Figure 3.1 give the individual's learning style.

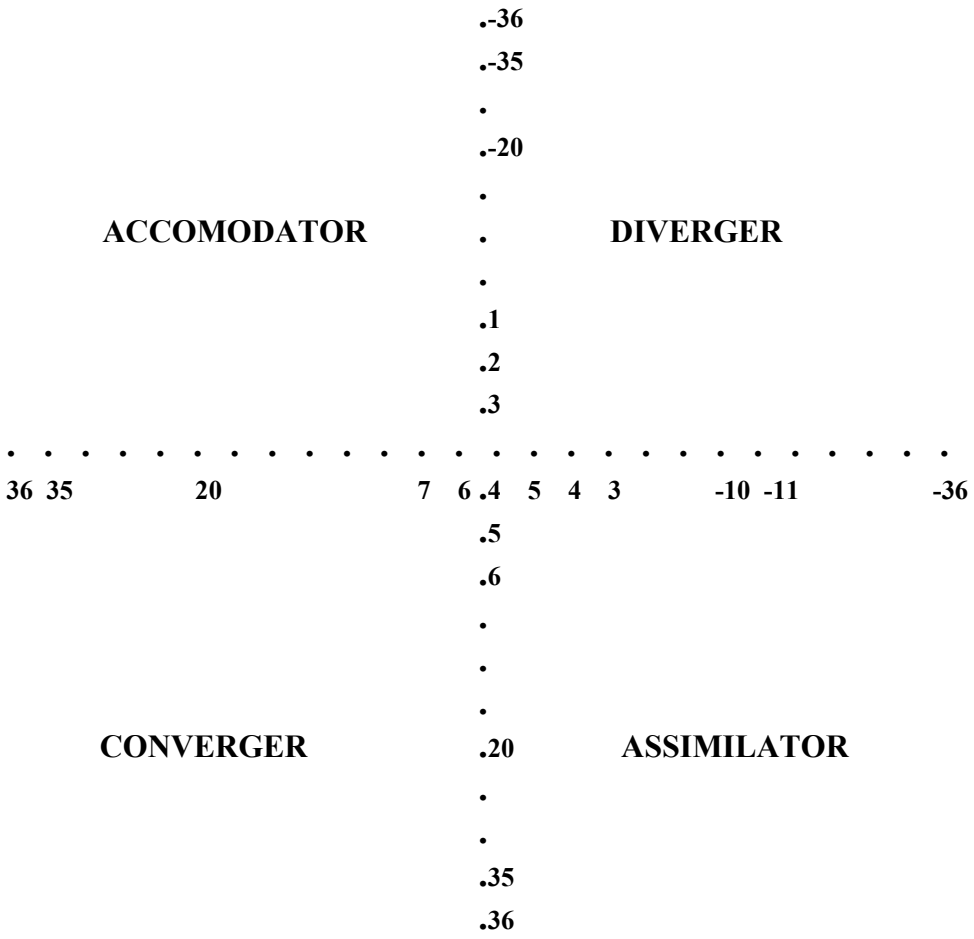


Figure 3.1 Kolb's Learning Styles

3.3 Procedure

The central premise of this study was to investigate the effects of journal writing with or without giving feedback and grade compared to the expository teaching on students' understanding of integral. For this study, two new achievement tests, pre-test and post-test were developed. Pre-test was developed by taking into consideration high school curriculum. Post-test was developed by taking into consideration the content of the course. The pre-test was administered to all groups before the instruction in integral and the post-test was administered to all groups after the instruction in integral. For the pre-test 30 minutes, for the post-test 50 minutes regularly scheduled class hour were given. The tests were administered with an interval of 1.5 months between them. The tests were administered on the same day in the following class hours. In addition to this, to minimize misunderstandings in the questions of the achievement tests due to English language, Turkish translations were done during the administration of the tests by the researcher. Students were also asked not to worry about the spelling or grammatical mistakes and allowed to use Turkish in their responses. Following the administration of the tests, a detailed solution key for each test and scoring criteria for each question in the tests were developed. In order to develop the scoring criteria, the students' answers and explanations on each question in the tests were examined and classified separately. Subsequently, a thorough comparative study of all answers was carried out and six-point rubrics were written for each question in the achievement tests. Each rubric was developed to measure the accuracy, strength of justification and degree of conceptual understanding shown by responses. Prior to developing the individual rubrics, a general rubric taken from Ubuz (1996) was used to define criteria for determining individual points for specific rubrics. The highest score of 5 was awarded for responses which teachers and examiners regarded as being entirely correct at elementary calculus level, while the lowest score of 0 was given for missing answers or "do not know". The general rubric for scoring is shown in Table 3.4

Table 3.4: General six-point rubric for the achievement tests

SCORE	RESPONSE
5	▪ Answers including the relevant ideas, relationships, generalizations, applications or explanations considered at the introductory calculus. ▪ Including only minor computational errors, if any.
4	▪ Answers including relevant ideas with some evidence of knowledge of relationships, generalization, applications or explanations.
3	▪ Answers' exhibiting a moderate amount of reasoning but reasoning is incomplete. ▪ Answers including important sub ideas without necessary reasoning and explanations. ▪ Answers which are not totally complete in reflecting all aspects of the problem.
2	▪ Answers containing some relevant fact(s).
1	▪ Answers which are insufficient to allow any judgment. ▪ Answers showing no understanding of the problem ▪ Answers containing words, examples or diagrams that do not reflect the problem.
0	▪ "Do not know" or missed.

Detailed scoring criteria for each question in Pre-test and Post-test according to the six-point rubric were presented in Appendix E and Appendix F, respectively. According to those scoring criteria for each question, the results of the tests were graded. In addition to these, Learning Style Inventory administered as a pre-test was used in order to determine the learning styles of the students. .

The study was carried out in 2003-2004 fall semester at Atilim University. The treatment lasted in six weeks. All engineering students who were taking the Calculus I course and constituted three groups were taken as the sample of the study. Control and the experimental groups (CG, EG1 and EG2) were randomly assigned to the groups. All the groups were taught the same topics with expository teaching by different instructors. The only difference between the control group and the experimental groups was that, the experimental groups were engaged in journal writing activities at the end of lectures allowing 5-10 minutes to complete while the control group was not. On the other hand, the difference between the EG1 and the EG2 was that, EG1 students' journal writings were graded and feedback was given to

the students about their writings. The journal writing prompts were applied to two to four times in a week during the 6-week period. The prompts were provided by the researcher depending on the concepts introduced during the lessons. Each journal writings were given on a sheet of paper by providing a space for writing. In order to avoid misconceptions due to English language, the researcher explained the prompts in Turkish to the whole groups. Also, the students were told not to worry about spelling or grammatical mistakes. In addition to this, the students were permitted to use Turkish in their answers if they have difficulty in expressing their ideas in English. The lessons, mainly the lessons of the EG1 and EG2, were observed during the treatment since the two class hours of the CG and EG2 were at the same time. Because of that, every week two class hours of four class hours of CG were observed.

Following the completion of the treatment, a series of face-to-face interviews were conducted with 10 students from EG1 (5 students) and EG2 (5 students) in order to investigate the students' opinions about journal writing activities, grading journal writings and giving feedback. Students for the interviews were chosen according to their exam grades and attendance to the classes during the treatment (See Table 3.5). For the exam grades, the means of the grades were used as a reference (Mid-term I=34; Mid-term II=40; Final=30). The researcher was also the graduate assistant of the recitation hours of the groups. This could be taught as a limitation of the study, since one can think that the students do not feel themselves totally free to express their opinions. On the other hand, this can be advantageous also, since the researcher knows the students and the communication between the researcher and the students makes the interviews more detailed.

Table 3.5 Interviewed Students' Characteristics in Terms of Gender, Exam Grades and Attendance

Groups	Student	Gender	Mid-Term I	Mid-Term II	Final	Attendance
EG1	**S1**	F	68	94	79	100%
	S2	M	9	58	44	85%
	S3	M	35	45	23	100%
	S4	M	29	55	33	100%
	S5	M	7	24	15	85%
EG2	**S6**	M	15	8	22	85%
	S7	M	44	55	37	85%
	S8	M	78	87	82	100%
	S9	M	77	80	70	100%
	S10	M	66	76	41	100%

Note: "F" represents "Female", "M" represents "Male"

The interviews were semi-structured. During the interviews, first the researcher explained the aim of the study, then asked for permission to record the interviews and then posed the previously prepared questions. Although the interviews for the study were primarily structured, the researcher spontaneously reacting to students' responses imposed some unstructured. Each interview lasted approximately 20 minutes. The interview tone was friendly and non-threading. The researcher tried to make the students comfortable with their answers and critiques. The main line of inquiry was to ask the students to explain their ideas, critiques and suggestions about journal writing activity. With this purpose, the following questions were posed to the students in both experimental groups:

- How has journal writing affected your learning of mathematics?
- Which type of journal writing (affectively oriented or cognitively oriented) has affected you more than the other? Why?
- Would you like to continue this activity?
- What do you think about the timing and frequency of journal writings? Do you have any suggestions about them?

The questions given below were posed only to the EG1 students (S1, S2, S3, S4, and S5)

- Did grading affect your view about journal writing? If yes, how has grading affected your view about the activity?
- Did having feedback about your journal writings affect your learning of mathematics? If yes, how has it affected your learning of mathematics? If no, why?

The questions given below were posed only to the EG2 students (S6, S7, S8, S9, and S10)

- Your journal writings were not graded. Did this affect you? If yes, how; if no, why?
- You were not given any feedback about your journal writings. How has this situation affected you?
- Would you like to have feedback for journal writing activities?

In this study, both quantitative and qualitative methods were used to analyze the data. For the quantitative analysis, data gathered from the pre-test, the post-test and the learning style inventory was coded and analyzed by using SPSS. There were two independent variables, treatment which has three levels (Journal Writing, Journal Writing with grading and feedback and, Traditional teaching) and learning style which has two levels (Assimilator and Converger) and one dependent variable (post-test scores). The design of the study was a pretest-posttest design involving a 3x2 ANCOVA model.

For the qualitative analysis, transcripts of the interviews were used. Analysis of the interview results involved a careful reading of each interview transcript, while attempting to identify common responses under three main topics: Views about journal writing activities; views about feedback; views about grading.

3.4 The Treatment for the Experimental and Control Groups

The course, Math 151, taught to all groups aimed at providing a foundation of mathematical methods and techniques for use in engineering courses. As mentioned

previously, the groups were taught by different lecturers who were experienced in teaching calculus. Before the semester started, they had come together to decide on the syllabus and the flow of the course. In addition to this, they came together in three or four weeks to discuss on the lectures such as the attendance, understanding and the difficulties of the students. Then they discussed on how to deal with such problems. All of these arrangements made the lectures in each group flow in a harmony.

The schedule for the integral topics was seven weeks but it lasted in six weeks. So the last week of the semester was used for a general revision. The topics of the lessons covered in the course together with the class hours were presented in Table 3.6.

Table 3.6: Topics taught in integral with their scheduled class hours

Week	Date	Topics Covered
IX	Nov.17-21, 2003	Indefinite Integrals; Integral Rules; Integration by Substitution
X	Nov.24-28, 2003	Riemann Sums and Definite Integrals; The Mean Value and Fundamental Theorems; Substitution in Definite Integrals; Volumes by Slicing and Rotation About an Axis
XI	Dec.1-5, 2003	Volumes by Slicing and Rotation About an Axis
XII	Dec.8-12, 2003	Modeling Volume Using Cylindrical Shells; Lengths of Plane Curves; Logarithms; Exponential Functions
XIII	Dec.15-19, 2003	Integration by Parts; Partial Fractions; Trigonometric Substitutions
XIV	Dec.22-26, 2003	Improper Integrals

Classes met six class hours a week for 50 minutes each. Four hours were used by the instructors for the lectures. Remaining two hours called recitation hours were used by the graduate assistant to make the students met in the computer laboratories

for either problem solving or computer applications of the topics taught in the lectures.

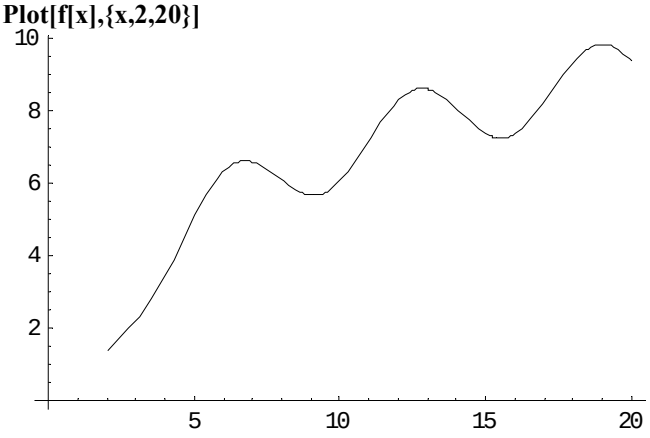
The method used in lessons was lecturing. The authority in the lessons was the instructor who directed the flow of the all lectures. Each lesson was started with a brief review of the previous lesson by summarizing the important rules, definitions or procedures for 5-10 minutes. After the review, the lesson continued with solving examples related to the topics taught previous lesson or with a new topic. While presenting a new topic, the instructors asked a question to draw attention to the new topic. Then they started to the topic pretending to answer the questions. For example, before starting to introduce substitution method, the instructors summarize the antiderivative concept and the basic integral rules. Then, present an integral which would be evaluated by using substitution method, and ask how to evaluate that integral. While explaining the solution, he/she also presents the new method. Questioning was also used to build an interaction between the instructor and the students during the lectures. The instructors mainly focused on the procedural parts of the topics instead of conceptual parts of the topics such as definitions or theorems. For example, they just explained indefinite integral as the set of all antiderivatives but did not mention anything related to Riemann Sum. They tried to teach the procedures for solving integral questions. To do this, they solved various examples.

As mentioned above, the recitation hours carried out by graduate assistants were used for problem solving and computer applications of the topics. Every week, one hour was used for problem solving; one hour was used for computer applications. In the problem solving hours, varied problems were solved for the topics which were taught in that week. For example, evaluating the following integral, $\int \sin^5(3\theta)\cos(3\theta)d\theta$. In the mathematica application hours, the students were introduced numerical, symbolic and graphical calculations to understand calculus better as well as to handle complicated computations that can not be done by hand. The book used for the mathematica applications was "A Manuel of Mathematica for Calculus of One variable" (Başkaya, Bayazıt, Tosmur, and Tosun, 2003). An example of mathematica application in integral is given below to show the CAS's usage in calculus.

As engineering candidates, the students need to solve complicated integrals. For example, in order to find the area under the curve $y=\log(x^3 -2) + \cos x$ on [2,20], he/she need to know where the function is positive and negative. In addition to this, he/she should know x and y-intercept, and the integral of the function $f(x)= \log(x^3 -2) + \cos x$. These are not so easy to do just by hand. But the student can do them by using small number of mathematica commands as shown below. So, they would be able to enlarge their mathematics knowledge in more complicated computations.

First, let's draw the graph of the function on the given interval.

```
f[x_]=Log[x^3-2]+Cos[x]
Cos[x]+Log[-2+x^3]
Plot[f[x],{x,2,20}]
```



As it is seen from the graph, the function is positive on the given interval and there is no x or y-intercept. So, it is enough to evaluate the integral on the given interval as below,

```
Integrate[f[x],{x,2,20}]//N
121.327+0.i
```

During the semester, the students had five calculus quizzes and five mathematica application quizzes in recitation hours. In addition to these, the students were assigned six homeworks whose questions were taken from the book used in the course and called "Thomas' Calculus" (Finney, Weir and Giordano, 2001).

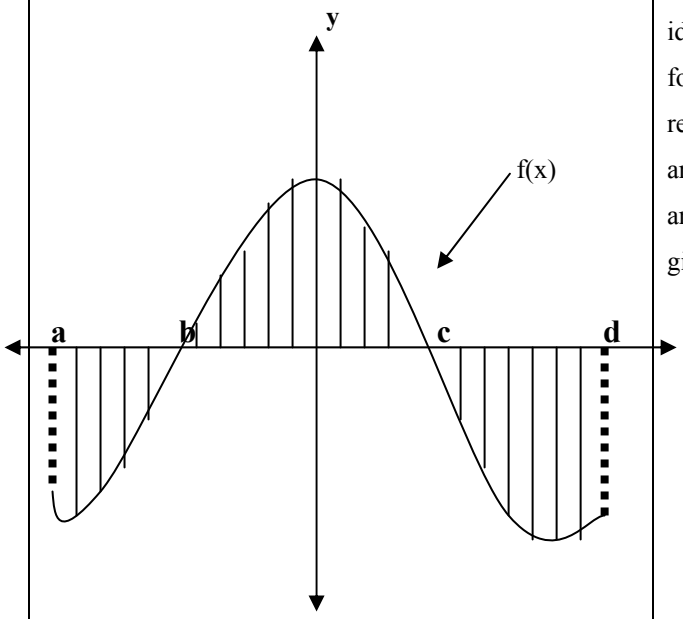
3.4.1 Journal Writing Method in the Experimental Groups

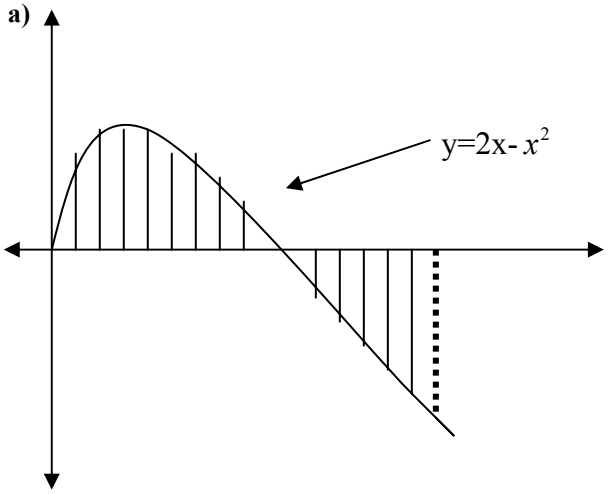
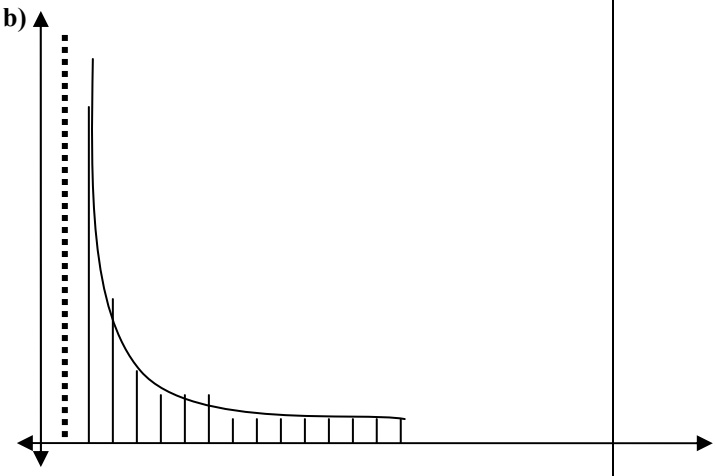
Fourteen journal writings were developed to allow students to communicate their knowledge about mathematics, their thoughts and feelings about the components of the mathematics classroom and their difficulties related with integral. Prior to the treatment in integral, the students in EG1 and EG2 were given 10 journal writings related to limit, continuity and derivative to make them get used to the activity. Two types of journal writings, cognitively oriented journal writings and

affectively oriented journal writings, were used in this study. Nine of the journal writings were cognitively oriented; five of the journal writings were affectively oriented. Cognitively oriented journal writing prompts focused on the learning of mathematics. Affectively oriented journal writings focused on the students' thoughts and feelings about the components of treatments and their difficulties related with integral. All the journal writings were designed parallel o the lectures. For example, the lectures were mainly taught procedurally so the journal writing prompts were not so much conceptual. Each journal writing and its aim is given in Table 3.7.

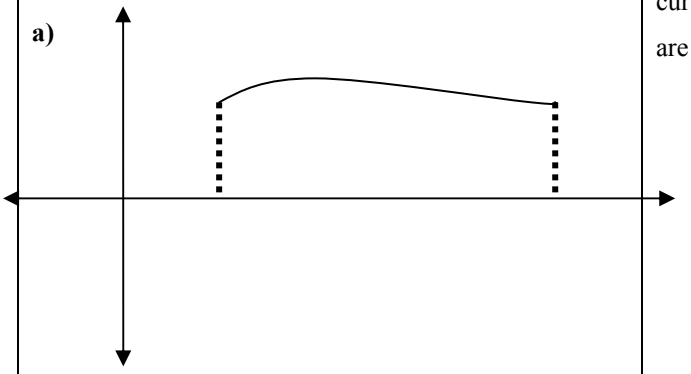
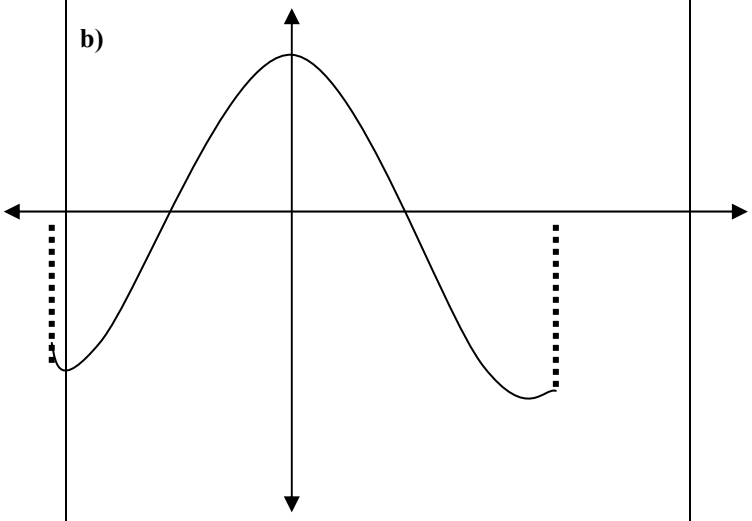
Table 3.7: Journal writing prompts and their aims

Week	Journal Writing	Journal Writing Prompts	Aim of the Journal Writing
First	**1**	What did you learn about the integral concept in this lesson? Clarify your answer by using as many ways as you can (you can use verbal explanation, charts, examples, tables...).	To make the students summarize the lesson in their own words. To understand how the students internalize the lesson.
	2	What do you feel about the course, considering the teaching, homeworks, quizes, recitation hours, exams...etc.	To identify the feelings of the students about the teaching and the components of treatment.
Second	**3**	If the following equality is given, $\int x^2\cos(2x)dx=\frac{1}{2}x\cos(2x)+\frac{1}{4}(-1+2x^2)\sin(2x)+C$ How can you check its correctness? Please check if it is true or false?	To understand whether the students comprehend antiderivative concept.
	4	Evaluate the following integral, $\int\cos(x^2)d(x^2)$	To make the students recognize the integrand variable.

Third	**5(a)**	We can differentiate an integral by ……(Theorem).	To make the students state the Fundamental Theorem of Calculus by the help of its one of usage.
	5(b)	Find the derivative of $\int_0^1 [x^3 2^x Cos(x+7)]dx$. Explain your answer as much as possible.	To make students recognize that definite integral produces a constant and its derivative is zero.
	6	Given the graph of the function f(x) as follows,  The area between the function f(x) and the x-axis equals to **a)** $A = \int_a^d f(x)d(x)$ **b)** $A = \int_a^b f(x)d(x) - \int_b^c f(x)d(x) + \int_c^d f(x)d(x)$ **c)** $A = \int_a^b f(x)d(x) + \int_b^c f(x)d(x) - \int_c^d f(x)d(x)$ **d)** $A = -\int_a^b f(x)d(x) + \int_b^c f(x)d(x) - \int_c^d f(x)d(x)$ **Explain your answer as much as possible.**	To make students to identify the correct form of the symbolic representation of the area between a curve and x-axis from a given graph.

Fourth	**7**	What kind of difficulties you have experienced about the integral topic. According to you, what are the most difficult parts of integral topic? Explain as much as possible (you can use verbal explanations, diagrams, tables, examples….any way you want).	To identify the difficulties of the students related with integral.
	8	When the shaded regions below are rotated through 360° about x-axis, a solid is traced out. **a)**  **b)**  If possible, write down the integral formulas for the volumes of the above solids. If it is not possible, explain why not?	To make students write down the integral formulas to evaluate the volume of a solid generated by revolving the region between a curve and x-axis whose graphs were given about x-axis by using any method they would like.

	9	List all of the mistakes that you have made in class, on homeworks, on quizzes and on activities about the integral concept.	To identify the difficulties and misconceptions of the students related with integral.
	10	Write down (construct) an integral in which **a)** Integration by parts **b)** Partial fraction **c)** Trigonometric substitutions method should be used to evaluate the integral. (**Do not evaluate the integrals)**	
Fifth	**11**	After the second exam, evaluate your exam and write down the RIGHTS and WRONGS while you were working for the exam and attending to lectures. If you had a second chance to take the exam, what would you do different from this?	To make the students think about the exam before the results explained. To identify the strengths and weaknesses of the students about integral.

	12	Can we evaluate the lengths of these two curves? If yes, write down the formulas for the lengths of the curves? Here are the two curves, **a)**  **b)** 	To make the students write down the formulas to evaluate the length of the curves whose graphs are given.
	13	Write down all the things that you feel about a) The Course b) Teaching c) Quizzes d) Homeworks e) Recitation Hours	To identify the feelings of the students about the teaching and the components of treatment.
	14	If $\int_0^1 f(x)d(x) = 4$ and $f(x) \geq 0$, does $\int_0^1 \sqrt{f(x)}d(x) = \sqrt{4} = 2$ hold?	To make the students recognize that the integral of a product is generally not the product of the individual integrals.

Journal writings were given to both experimental groups (EG1 and EG2) at the end of class hours allowing 5-10 minutes to complete. For the first four weeks, the experimental groups were given journal writings at the end of 2-class hours. For the last two weeks, the experimental groups were given journal writings at the end of each class hours. Each journal writing was given on a piece of paper including a written prompt on it. While students completing their journals, they were allowed to use Turkish if they feel that they can not express themselves clearly in English. All the journals were graded but, only the students in EG1 were announced their grades. Additionally, the students in EG1 were given feedback about their writings. The procedure for the grading and feedback was as follows: the researcher applied and collected the journal writings. Then, she evaluated them and wrote the grades and the feedbacks on the journals. In the following lecture, at the end of the lecture before distributing the new journal writings, she distributed the previous journal writings with their grades and feedback on them.

In order to evaluate cognitively oriented journal writings, a general rubric developed by Ubuz (1996) (see Table 3.4) was used. For each journal writing activity the students' answers and explanations on each question were detected and classified. Subsequently, a thorough comparative study of all answers was carried out and a specific six-point rubric was developed in the light of the general rubric. Journal writing prompts and their scoring tables were presented in Appendix C and Appendix G respectively. In order to analyze the affectively oriented journal writings related to the attitudes and feelings of the students, each statement was detected as positive or negative. On the other hand, the affectively oriented journal writings that are related to the difficulties of the students were analyzed by presenting the frequencies of the difficulties mentioned by the students.

3.5 Limitations of the Study

The study was subject to the following limitations:

1. The study was not a true experimental study in which all study participants were randomly selected before implementing the treatment.
2. Each group was taught by different instructors. So the characteristics of the instructors may affect the study.

3. Only the researcher observed the lessons.
4. The researcher could not observe all the lesson of the CG.

3.6 Assumptions of the Study

The researcher made the following assumptions for the study:

1. The subjects of the study answered the items of the tests honestly and accurately.
2. The students in EG1 and EG2 answered the journal writing prompts honestly and accurately.

3.7 Internal Validity

Internal validity is the extent to which detected differences on the dependent variables are associated to the independent variables and not to some uncontrolled variables. Threats to internal validity are alternative explanations of the results that are not related to the treatment. A list of all possible threats to the internal validity of the study and how they were minimized or controlled were discussed in this section.

This study was carried out on intact groups that is individual students were not randomly assigned to the groups. This might bring the subject characteristics threat to the study. However, this threat could not be controlled in this study.

In order to control the history effect, groups were administered all the tests approximately at the same time. By this way, similar situations were tried to be provided. Moreover, the results of the treatment may be associated with specific events occurring between pre-test and post-test. But, this was not an issue because the length of the study was limited to six weeks period and during that period, anything very unusual that could influence the groups had happened.

The location in which data were collected could provide an alternative explanation for the outcomes of the study. This study was carried out in two almost same classrooms. These similar situations and administration of all tests and activities at the calculus lessons were remedy for the possible location threats. Besides these, no outside event were observed during the treatment and testing that could influence the subjects' responses.

Another likelihood of threat might be the administration of pre-test that is, exposure to pre-test could change the subject performance in related post-test. All the

groups were administered pre-test to equalize the pre-testing effect on the groups. Moreover, a new test was developed as the post-test which would also disqualify this effect. Besides, there were six weeks period between the tests which was assumed to be sufficient for desensitization. Furthermore, the pre-test was checked to see whether it was related with the post-test. Then, it was assigned as the covariate for the statistical analysis.

Mortality refers to loss of students during the treatment. There were missing data in the tests and the activities due to the loss of students. The students who had not taken at least one of the tests or more than three journal writing activities were not taken as the subject of the study. However, this effect could not be controlled.

Maturation threat means that the results of the treatment may be associated with the passage of time rather than treatment. This was not an issue because the length of the time was limited to six weeks. Besides, the same amount of time was passed for the all groups.

The instrumentation threats can be in the form of instrument decay, data collector characteristics and data collector bias. In this study, although open-ended questions were used, using a general rubric helped to make the instrument decay not a viable threat. Data collector was the researcher for the all groups which would be a remedy for the data collector characteristics and the data collector bias.

It is possible that the person administering a treatment may be the cause of the results or any observed outcomes. For the implementation effect, the researcher tried to be disinterest and unbiased during the administration of journal writing activities.

Furthermore, outcomes of the research might be affected by Hawthorne effect which was not controlled in this study.

CHAPTER IV

RESULTS

In this chapter, the results of the pre and post-tests together with the comparison analyses are given in detail. In addition to this, the analysis of the affectively oriented journal writings and the interviews related to journal writing, grading and feedback are reported. To analyze the results of the study both quantitative and qualitative methods were used.

For the quantitative analysis, the following research question was sought:

- Is there a significant difference in the performance scores of students on integral that can be attributed to: (i) treatment, (ii) learning style, and (iii) interaction of treatment and learning style?

For the qualitative analysis, the following research questions were sought:

- What are the students' opinions about the journal writing activities?
- What are the students' opinions about grading and feedback?
- What are the students' difficulties related to integral?
- What are the students' views about the treatment?

4.1 Descriptive and Inferential Statistics of Pre and Post-Tests

The Box-and-Whisker plots and the descriptive statistics of the pre and post test scores for the EG1, EG2 and CG are presented in Figure 4.1 and Table 4.1 respectively.

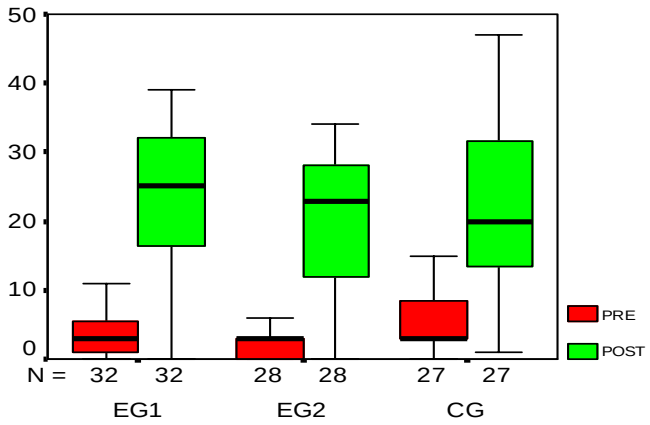


Figure 4.1: Box-and-Whisker plots of pre and post-test scores for EG1, EG2 and CG.

In the Box-and-Whisker plots (Figure 4.1), the rectangles for pre-test indicate that although the median for all groups are the same, the CG has slightly greater median for the upper half data than the experimental groups. Among the experimental groups, EG1 has slightly greater median for the upper half data than the EG2. In addition to this, it can be concluded from the Box-and-Whisker plots that EG2 has the smallest range while the control group has the largest range. Lastly, it should be pointed out that, the scores between first and third quartile, which includes mid 50% of the scores, for EG1 are between 1 and 6.25, for EG2 between 0 and 3, and for the CG between 3 and 9. The number of students whose grades are greater than 6.25 that represent the third quartile for the EG1 are 8(25%) for EG1, 5 (17%) for EG2 and 9 (33%) for CG. On the other hand, the number of students whose grades are greater than 3 that represent the third quartile for the EG2 are 11(34%) for EG1, 6(21%) for EG2 and 13(40%) for CG. Finally, the number of students whose grades are greater than 9 that represent the third quartile for the CG are 5(15%) for EG1, 4(14%) for EG2 and 6(22%) for CG. As a result, although there is little performance difference in pre-test between EG1 and CG in favour of CG, there is large performance difference in pre-test between EG2 and CG in favour of CG. In addition, there is little performance difference in pre-test between EG1 and EG2 in favour of EG1.

When the Box-and-Whisker plots are analyzed for the post test, the followings can be reported: the median scores of the groups slightly differ in favour of EG1. The CG has the smallest median while it has the largest median in pre-test. The CG has the largest range while the EG2 has the smallest. When the rectangles are considered, it can be easily observed that the scores between first and third quartile, which includes mid 50% of the scores, for EG1 are between 16.25 and 32.5, for EG2 between 11.5 and 28.5, and for CG between 13 and 32. Lastly it should be indicated that, the number of students whose grades are greater than 32.5 that represent the third quartile for the EG1 are 8(25%) for EG1, 3(11%) for EG2 and 5(18%) for CG. On the other hand, the number of students whose grades are greater than 28.5 that represent the third quartile for the EG2 are 12(37%) for EG1, 7(25%) for EG2 and 9(33%) for CG. Finally, the number of students whose grades are greater than 32 that represent the third quartile for the CG are 8(25%) for EG1, 3(11%) for EG2 and 5(18%) for CG. To sum up, it can be observed that there is slightly little performance difference in post test between the groups in favour of EG1. Between the EG2 and CG, CG has slightly higher performance in post-test.

Table 4.1: Descriptive statistics of the pre and post tests

	EG1		EG2		CG	
Statistics	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
N	33	33	28	28	27	27
Mean	4.55	23.63	3.96	20.46	6.04	22.07
Median	3	25	3	23	3	20
Mode	3	25	3	26	3	6
Std.Error of Mean	1	1.87	0.92	1.86	1.15	2.22
Std.Deviation	5.69	10.57	4.85	9.82	5.98	11.53
Variance	32.36	111.79	23.52	96.41	35.73	132.92
Skewness	1.72	-0.631	1.64	-0.478	1.04	0.22
Kurtosis	1.99	-0.236	1.80	-0.722	-0.188	-0.596
Range	20	39	16	34	19	46
Minimum	0	0	0	0	0	1
Maximum	20	39	16	34	19	47
Quartile I	1	16.25	0	11.5	3	13
Quartile II	3	25	3	23	3	20
Quartile III	6.25	32.5	3	28.5	9	32

Note: Maximum score in pre-test is 35 while the maximum score in post-test is 75.

As it is seen from Table 4.1, EG1 showed a mean increase of 19.08, EG2 showed a mean increase of 16.5 and CG showed a mean increase of 16.03. So, it can be concluded that EG1 gained slightly greater achievement than EG2 and CG.

The Box-and-Whisker plots and descriptive statistics showed little performance difference between the groups. To check if the difference is significant or not for both pre and post-test scores some statistical techniques were conducted. A one-way analysis of variance (ANOVA) was conducted on the pre-test scores in order to examine whether there was a significant difference between the groups prior to the instruction of integral. The results showed that there was no significant difference between the groups with respect to pre-test prior to the instruction of integral ($F=1.027$, $p=0.363>0.05$).

A 3x2 analysis of covariance (ANCOVA) was conducted on the post test scores to seek out the effects of three treatments-journal writing with grading and feedback, journal writing and traditional teaching, and two learning styles-assimilator and converger on the students' performance in integral. Pre-test scores were used as a covariate to remove the extraneous variations from the gain scores, thereby increasing measurement precision (Hendriz, Carter and Hintze, 1979). Although there was no significant difference between the groups with respect to the pre-test prior to the instruction of integral ($F=1.027$; $p=0.363>0.05$), pre-test and post-test results were correlated and found that there was a significant correlation between pre test and post test ($\rho=.336$; $p=.001<0.01$).

The ANCOVA was done because the research questions aimed at: (a) establishing whether the three treatments-journal writing with grading and feedback, journal writing and traditional lecturing would significantly improve students' performance in integral; (b) whether the students' learning style would significantly improve students' performance in integral; and (c) whether the interaction of students' learning style and treatment would significantly improve student' performance in integral.

The statistical technique ANCOVA has five assumptions: Independency of observations, normality, equality of variances, correlation between the dependent variable and the covariate and no custom interaction between the independent variables and the covariate. Independency of observations was met with the observations of the experimental groups and the control group by the researcher. It was also observed that all participants did their activities and the tests themselves. For the normality assumption, skewness and kurtosis values were used. The skewness and kurtosis of scores on the post-test were in acceptable range for normal distribution (skewness= -0.228; kurtosis= -0.583). Levene's Test of Equality was used to determine the equality variance assumption. Results showed that the error variances of the post-test across the groups were equal ($p=0.844$). As indicated above, the correlation between the dependent variable and the covariate is significant ($\rho=.336$; $p=.001<0.01$). Lastly, for ANCOVA homogeneity of slopes assumption was tested. Results indicated that pre-test scores, as a covariate, was not a function of the independent variables (p (Groups and Pre-Test) $=0.193$, p (Learning Style and Pre-Test) $=0.080$).

A summary of ANCOVA analysis is presented in Table 4.2. The tabulated results showed that: (a) there is no statistically significant difference due to the treatments (F (2, 87) =1.295, p=0.280>0.05); (b) there is no statistically significant difference due to the learning styles (F (1, 87) =2.270, p=0.136>0.05); and (c) there is no statistically significant interaction between the treatment and learning styles (F (2, 87) =2.215, p=0.116>0.05). The results also showed that the treatment explained only 3.1% of the variance of the model while the learning styles explained only 2.8% of the variance of the model.

Table 4.2: Values of F, p, η^2 for ANCOVA for post-test

Effect	**SS**	**Df**	**MS**	**F**	**P**	η^2
Group	251.904	2	125.952	1.295	.280	.031
Learning Style	220.800	1	220.800	2.270	.136	.028
Group and Learning Style	431.033	2	215.516	2.215	.116	.052

Although the results in Table 4.2 indicate that there was no statistically learning style difference in students' performance in integral, it was considered necessary to display their pre and post-test mean scores for a more detailed scrutiny.

Table 4.3: Means and standard deviations of pre and post-test scores of EG1, EG2 and CG with respect to learning styles.

Group	Learning Style	Pre-Mean	Post-Mean	Pre-Std. Dev.	Post-Std. Dev.	N
EG1	Assimilator	6.33	22.71	6.31	11.11	21
	Converger	1.16	25.36	1.15	9.72	11
	Total	4.55	23.63	5.69	10.57	32
EG2	Assimilator	4.56	18.50	5.72	10.28	18
	Converger	2.90	24.00	2.60	8.25	10
	Total	3.96	20.46	4.85	9.82	28
CG	Assimilator	4.41	22.12	4.59	12.54	17
	Converger	8.80	22.00	7.22	10.22	10
	Total	6.04	22.07	5.98	11.53	27
Total	Assimilator	5.18	21.18	5.62	11.26	56
	Converger	4.19	23.84	5.39	9.23	31
	Total	4.82	22.13	5.53	10.61	87

The results, which are displayed in Table 4.3, showed that the students having assimilator learning style and the students having converger learning style slightly differ in pre-test in favour of the students having assimilator learning style for the experimental groups (EG1 and EG2). It is just the opposite for the CG: Students having converger learning style is a bit more advantageous than the students having assimilator learning styles in pre-test. On the other hand, when the post-test mean scores are considered in terms of learning styles; it is seen that, for EG1 and EG2, the performance of students in post-test slightly differ in favour of the students having converger learning style. For the CG, the mean scores of the students having assimilator learning style and converger learning style are almost the same in post-test.

4.2 Explanatory Results of the Pre-Test, Post-Test and Journal Writings

In this section, firstly the results of the pre-test will be discussed according to the topics covered in it. Then, the results of the post-test and journal writings will be detected according to the topics that were covered in the post-test and journal

writings. The results of the pre-test were examined separately from the results of post-test and journal writings. The pre-test was designed to investigate students' prior knowledge related to the integral concept before the instruction. On the other hand, the post-test was designed to investigate whether the journal writing activities were affective tools in learning integral. So, it is taught to be better to represent the results of the post-test together with the results of the journal writing activities under the topics covered in them. While presenting the results of the pre-test, post-test and journal writings, the expression "related answer" will be used. This expression refers to the answers scored as 2, 3, 4 or 5 according to the six-point rubric. Because, as it can be understood from the six-point rubric, the answers including some correct explanations are scored as 2, 3, 4, or 5, while the answers that are totally incorrect or missed are scored as 1 or 0, respectively.

To present the students' approaches to the questions in the pre-test, examples of students' responses for each question according to the six-point rubric, given in Table 3.4, and frequencies with percentages of students in it is presented in Appendix E. When Appendix E (presenting pre-test results) is considered for the first question, which is related to the definition of integral, it can be seen that more than half of the each groups have an idea about the integral concept. On the other hand, when question two related to integral techniques is detected, it is seen that very little percentages of the students have an idea about the integral techniques in each group. But, if we compare percentages between the groups, it can be concluded that control group has slightly more idea about integral techniques than the EG1 and EG2 before the instruction. For question three related to the area applications of integral, although 15% of the students in EG1 and EG2 have an idea about the topic, it is 30% for the control group. Lastly, if question four related to the volume of revolution is investigated, it can be easily concluded that all the groups have almost no idea about the volume applications of integral before the instruction.

As it is mentioned above, the results of the post-test items and the journal writing tasks will be discussed under the topics covered in the post-test and journal writings. To present the students' approaches to the items in the post-test, examples of students' responses for each item according to the six-point rubric, given in Table 3.4, and frequencies with percentages of students in it is presented in Appendix F. In addition to this, the frequencies with percentages of students in cognitively oriented

journal writings, which are scored according to the six-point rubric, are given in Appendix G. Firstly, it would be better to present a general summary of results for both post-test and the journal writings. Then the results of the post-test items together with the related journal writing results will be discussed under the topics covered in them.

When Appendix F (presenting the post-test results) is considered, it is detected that item 4(d) related to area calculations is the most difficult item while item 7(a) related to properties of integral is the easiest one. In general, the scores are accumulated on 0, 1 and 2. For most of the items there are little percentages of students having 3, 4 and 5. EG1 has the most distributed scores while EG2 has the least.

When Appendix G (presenting the journal writing scores) is considered, it can be easily seen that percentages of students in EG2 who do not know or missed the items is greater than the students in EG1 for most of the journals. For both EG1 and EG2, journal writing 5(b) covering the Fundamental Theorem of Calculus is more difficult than the others and journal writing 6 covering area applications of integral is easier than the others. In general the scores are weighted mainly on 0, 1, and 2 for both groups. On the other hand, EG1 has more distributed scores than the EG2 for most of the journals.

Application of Fundamental Theorem of Calculus

Item one in the post-test and journal writing five (a and b) were designed to ascertain whether the students could apply the fundamental theorem of calculus. In item one, the students were asked to find the derivative of a function including a polynomial (x) and an antiderivative g(x). In the task 5 (a), the students are required to state the theorem (Fundamental Theorem of Calculus) in order to differentiate an integral. Lastly, the task 5 (b) required the students to recognize that the derivative of a definite integral is zero because of Fundamental Theorem of Calculus. For item one, 60% of the students in EG1 could give an appropriate or related answer while this percentage is 40 for EG2 and 41 for CG. When we consider the journal writing scores (5(a), 5(b)), it is seen that for the task 5(a), 47% of the EG1 gave some related answers while it is 8% for the EG2. On the other hand, for the task 5(b) the students in EG1 and EG2 gave incorrect answer or no answer at all.

Antiderivative Concept

Items two and three in the post-test and journal writing three were designed to examine whether the students knew the meaning of antiderivative and the distinction between an antiderivative and the indefinite integral of a given function. For the items two and three, the percentages of students whose answers are totally correct or having some related statements are as follows for each group: For item two, EG1 has 79%, EG2 has 40% and CG has 59%; for item three, EG1 has 54%, EG2 has 36% and CG has 36%. On the other hand, when the journal writing three is considered, it is interesting to see that although the percentages of students having an idea about the antiderivative concept in EG1 is 4%, it is 35% in the EG2.

Area Applications of Integral

Item four and journal writing six were designed to ascertain whether the students found out the symbolic representation of the area between a given curve and x-axis. Item four required a student to identify the correct form(s) of the symbolic representation of the area between a given curve and x-axis. On the other hand, journal writing six required a student to identify the correct form of the symbolic representation of the area between a given curve and x-axis from a given graph. For item four, the percentages of students whose answers are totally correct or having some related statements are 25-30% for each group. On the other hand, when the journal writing six is considered, it is seen that almost all the students have an idea about the topic. But no students in each experimental group answered the prompt as totally correct.

Arclength Applications of Integral

Item five in the post-test and journal writing 12 (a and b) required a student to explain how to evaluate length of a smooth curve over a closed interval. Although in item five the students were asked to explain how to evaluate length of a smooth curve over a closed interval and give an example verbally, in journal writing 12 (a and b) the students were asked to write down the formulas to evaluate the length of the curves whose graphs were given. For item five, the percentages of students whose answers are totally correct or having some related statements, it is seen that

EG1's percentage is 49, EG2's percentage is 13 and the CG's percentage is 19. Besides, EG1 has more distributed scores while EG2 and CG have mainly 2. When the journal writing 12 is detected, it is not surprising to see that percentages of students whose answers are totally correct or having some related statements in EG1 is 74% while it is 12% for the EG2.

Volume Applications of Integral

The aim of item six in the post-test and journal writing eight (a and b) were to make students to evaluate the volume of a solid. In item six, the students were asked to write down the integral formulas for the volume of the solid generated by revolving the region between two curves about the x-axis by using washer and shell methods. On the other hand, journal writing eight (a and b) were designed to make students write down the integral formulas to evaluate the volume of a solid generated by revolving the region between a curve and x-axis whose graphs were given about x-axis by using any method they would like. For item six, the percentages of students having totally correct or related answers are generally low for each group (EG1-31%; EG2-29%; CG-11%). When the groups are compared in between, EG1 and EG2 are more successful than CG. On the other hand, when the journal writing eight (a, b) scores are detected, the percentages are not significantly higher than the percentages of the item six in the post-test (EG1-39% (8a), 31% (8b); EG2-52% (8a), 17% (8b)).

Properties of Integral

Item seven (a, b, c, and d) in the post-test and journal writing 14 required students to comprehend the properties of definite integral. Item seven (a) were designed to ascertain whether the students know the order of integration rule for definite integral. Item seven (b) were designed to ascertain whether the students know the additivity rule for definite integrals. Item seven (c) were designed to ascertain whether the students know that the integral of a product is generally not the product of the individual integrals. Item seven (d) were designed to ascertain whether the students know the constant multiple rule for the definite integrals. On the other hand, journal writing 14 was designed to ascertain whether the students know all the rules for definite integrals. For item seven (a, b, c, and d), the percentages of students

having totally correct or related answers are generally moderate for each group (EG1-61%, 56%, 47%, 60%; EG2-65%, 60%, 47%, 61%; CG-%93, 67%, 40%, 70% for 7(a, b, c, d) respectively). When the groups are compared in between, CG is more successful than EG1 and EG2. Similarly, when the journal writing 14 scores are detected the percentages are not too much different for the experimental groups (EG1-44%; EG2-46%).

Integrand Variable

Item seven (e and f) in the post-test and journal writing four were designed to examine whether the students comprehend integrand variable. In the items seven (e and f), the integrand variable x was replaced by 2x+1 and u, and the students were asked whether the value of the integral is changed or not. On the other hand, in the journal writing four the students were given an integral whose integrand variable is x^2 and asked to evaluate the integral. For item seven (e and f), the percentages of students having totally correct or related answers are generally moderate for each group (EG1-46%, 50%; EG2-40%, 50%; CG-37%, 66% for 7(e, f) respectively). When the journal writing four scores are detected, it is a bit surprising to consider that in EG1 64% of the students' answers are correct or related, while 76% of the students' answers in EG2 are correct or related.

To sum up, when the results are considered in whole, it can be observed that none of the groups is better than any other. But, if the questions are detected in detail, it is seen that there is a difference between the groups due to the type of questions. In answering questions that are not routine and need different perceptions (Question 1, 2, 3, and 5) EG1 is more successful. On the other hand, for the routine questions of which students are familiar (7(a, b, c, d)), there is almost no difference between the groups. Lastly, there is almost no difference between the answers of the groups for the questions 4(a, b, c, d), 6, and 7(e, f). This could be due to the fact that the questions cover the topics (area and volume applications, integrand variable) that students have always difficulty (Orton, 1983). Maybe, there should be more journal writing activities related to those topics to get a significant improvement.

4.3 Analysis of Affectively Oriented Journal Writings

In this section, affectively oriented journal writings (Journal writing # 2, 7, 9, 11, 13) were analyzed for both EG1 and EG2 separately. The responses of students to these journals were categorized into two parts: Students' views about the components of treatment and difficulties of the students related to integral.

4.3.1 Students' Views about the Components of Treatment

The frequencies of the common arguments related to the components of treatment which are identified in the affectively oriented journal writings (Journal Writing # 2 and #13) are presented in Table 4.4 for both EG1 and EG2.

Table 4.4: Frequencies of arguments related to the components of treatment that are identified in the affectively oriented journal writings (Journal Writing # 2 and # 13)

Arguments	**Experimental Group 1 Journal Writings**			**Experimental Group 2 Journal Writings**	
		J.W.#2	**J.W.#13**	**J.W.#2**	**J.W.#13**
Views about calculus	P	6	27	2	15
	N	1	1	1	5
	Nt.		1		3
Views about teaching	P	8	23	2	18
	N		4		1
	Nt.		1	1	5
Views about the quizzes	P	8	20	2	16
	N	1	5	1	5
	Nt.	1	4		2
Views about the homework	P	6	14	3	14
	N	7	13	2	11
	Nt.	1	2		1
Views about the recitation hours	P	10	28	4	23
	N				1
	Nt.		1		1
Views about the exams	P				
	N	3			
	Nt.	1		1	
Views about the instructor	P	1	5	1	
	N				
	Nt.				
Views about the language of instruction (English)	P	1			
	N	1	2	1	6
	Nt.				

Note: "P" represents "Positive Attitude"; "N" represents "Negative Attitude"; "Nt" represents "Neutral Attitude".

By the help of these journal writings (Journal Writing # 2 and # 13), students expressed their views about the identified common arguments. As it is seen from Table 4.4, most of the students in both EG1 and EG2 expressed positive views about the course. They stated that mathematics is an enjoyable and necessary course. It is inevitable for engineering. It makes people think wider and in different perspectives. One of these students expressed her thoughts as follows:

> Mathematics is a course which makes us think and our minds work. Also, mathematics is a course that makes us more logical people. In addition to this, mathematics changes people's perspectives to events. (S11-EG1)

Only one student in EG1 and five students in EG2 expressed negative views about the course. Their negative thoughts stem from thinking that mathematics is a hard course. One such negative expression from a student's journal is as follows:

> The course is very hard to understand. It compels me very much. (S12-EG2)

Most of the students in both experimental groups (EG1 and EG2) expressed positive feelings about teaching. They claimed that their teachers explain the topics step by step and solve examples which make them understand better. One such positive expression from a student's journal is as follows:

> Type of teaching is very good. Our instructor is teaching very well. He teaches us the chapter, which is too hard, very simply (S13-EG1).

Four students in EG1 and one student in EG2 expressed negative thoughts about teaching which would stems from the fact that they expect to learn mathematics just by solving problems. One of these students expressed his thoughts as follows:

> The lectures are very theoretical. The lectures are very monotonic. It can be a bit more dynamic. (S14-EG1)

Students' views about the quizzes are mainly positive for both groups. But, there are also some students expressing negative or neutral views about the quizzes.

The students expressing positive views about the quizzes pointed out that they like quizzes because quizzes make them follow the lectures and see their deficiencies. One such positive expression from a student's journal is as follows:

> Quizzes are very useful. Because, they make us follow the lectures more carefully. Moreover, we check our knowledge by the help of quizzes. (S15-EG2)

The students expressing negative views about the quizzes stated that the quizzes were not enough to evaluate what they had learned. They also claimed that the quizzes had not taken the students attention. One of the students having negative views about the quizzes expressed his thoughts as follows:

> According to me, the quizzes are not very measurable. They do not take our attention to the lectures very much. (S16-EG2)

Students' reflections about the homework revealed that positive and negative views about the homework were balanced for both groups. Students' positive thoughts stem from the perception which sees homework as a tool making students understand the topics better and let them review the lessons. On the other hand, negative thoughts stem from the perception which sees homework as a burden that is hard and long. Examples for positive and negative thoughts are given below respectively:

> Homework is important because it lets us review the topics covered in the lectures at home. They make us understand the subjects better. Since we solve the problems, we understand the subjects better. (S17-EG1)

> Homework is not useful. They are meaningless for university education. They are very long and hard. Because of that everybody is cheating. (S18-EG2)

Almost all the students expressed positive views about the recitation hours in EG1 and EG2. They stated that recitation hours are very useful to learn the topics better. Because, in these hours the teaching assistants solve different problems related to the topics covered in lectures. Moreover, they have more chance to ask questions that they have trouble. One of these students expressed his feelings as follows:

> Recitation hours are very helpful. We fill the gaps in our learning. We better learn that we could not understand in the lecture. According to me every lecture should have a recitation hour. (S19-EG1)

A few students reflected their thoughts about the exams. Most of them were from EG1. Only one student was from EG2. The student in EG2 expressed his feelings as neutral. In EG1, three students expressed negative views and one student expressed neutral view. One of the students who had negative views about the exams expressed his thoughts as follows:

> In the exams, too much things are expected from us. We are not mathematics students. So, this many details in questions are meaningless. (S20-EG1)

The student who had neutral views expressed her thought as follows:

> The exams are normal. (S21-EG2)

A few students also expressed their views about the instructor. All the comments written on the journals were positive for the instructors. Some of which are as follows:

> He is a very good teacher. He teaches very well. He explains everything step by step which makes us understands better. (S22-EG1)

> He is very well. He helps us to understand better. He explains hard chapters very simply. So, it is easier for us to understand. (S23-EG2)

Lastly, some students expressed their feelings about the language of instruction. They asserted that language of instruction (English) affects them badly. They argued that they have difficulty in understanding the lecture because of language. One student wrote:

> Since the instruction is English, I have difficulty in understanding the lectures. (S24-EG1)

4.3.2 Difficulties of the Students Related to the Integral Concept

The frequencies of the common arguments related to the students' difficulties in integral concept which are detected in the affectively oriented journal writings (Journal Writing # 7, #9, and #11) are presented in Table 4.5 for both EG1 and EG2.

Table 4.5: Frequencies of the student' difficulties in integral which are identified in the affectively oriented journal writings (Journal Writing # 7, #9, and #11)

Difficulties		Experimental Group 1			Experimental Group 2		
		Journal Writings			Journal Writings		
		J.W.7	J.W.9	J.W.11	J.W.7	J.W.9	J.W.11
Integration Techniques	Substitution	3	2			1	
	Integration by Parts	5	3		4	5	
	Partial Fraction	1	1		1		
	Trigonometric Substitution	8					
	Reduction Formula	5			2		
Complications with Area Applications		9	12	4	2	3	5
Complications with Volume Applications		10	19	1	6	8	1
Length of Plane Curves		1					
Fundamental Theorem of Calculus			1				
Integrals of Logarithmic Functions		2	1	1	1	1	5
Integrals of Exponential Functions		2	1				1
Integrals of Trigonometric Functions		1	1		2	2	
All the Topics in Integral		1	1		4	2	1

As it is seen from Table 4.5, the students in EG1 mentioned more topics which they have difficulty about the integral than the students in EG2. The topics that are mentioned most by the two groups are area and volume applications of integral. Integral techniques are another topic that the students in both groups mentioned as difficult. On the other hand, the difficulties related with fundamental theorem of calculus, trigonometric substitution techniques and length of plane curves were mentioned only by EG1. Lastly, it can be inferred from the table that, length of plane curves, Fundamental Theorem of Calculus, Integrals of logarithmic, trigonometric, and exponential functions are mentioned as a difficulty by a few students.

4.4 Analysis of the Interviews

Based on the interview transcripts, three sections were composed to illustrate students' views on journal writing, feedback, and grading. In quotations given from

the interviews, S with a number for each individual represents the students interviewed. S1, S2, S3, S4, and S5 are the students from EG1; S6, S7, S8, S9, and S10 are the students from EG2. S1, S8, S9 are high level students; S2, S4, S7, S10 are middle level students and S3, S5 and S6 are low level students. The students were identified as high, middle and low level according to their exam grades which was explained in the previous chapter in detail.

4.4.1 Students' Views About the Journal Writing Activities

Students' views about the journal writings can be analyzed in four parts: Whether the journal writings affected their calculus learning; when and how often the journal writings should be conducted; whether the activity should be carried out in the future; which type of journal writings is more effective.

When the students were asked whether the journal writings affected their calculus learning, eight students asserted that journal writings affected their learning positively (S1, S3, S4, S5, S7, S8, S9, S10). Only two students (S2, S6) claimed that journal writings did not affect their learning. S2 and S6 expressed their views as follows:

> It could be beneficial for the students who studies regularly and understands the topics during the lectures well. But they were not suitable for me. (S2-EG1)

> The activities were not useful for me. Because I did not know anything. So what could I do in those activities? If I knew something it could be beneficial for me. By those activities I could see different questions and learn different points. (S6-EG2)

The students having positive feelings about the journal writings stated different benefits of the activity. They said that the activity is like a bridge between the students and teachers which make them closer to each other. They also believed that, this activity shows that the teachers care about them. Some academical benefits were also pointed. Some of the students (S7, S8, S9, and S10) asserted that, the activity freshens their knowledge and detects what they know and do not know. In addition to these, the activity was claimed to show the theoretical parts of the topics and attract their attention to the lectures.

> It is a very good activity. It shows us that our teachers care about us. It also makes us analyze our knowledge. (S1-EG1)

> I am happy about this activity. It freshens our knowledge. It also encourages me study calculus. (S7-EG2)

When the students were asked when and how often the journal writings should be conducted we got a common answer for the question when it should be conducted. On the other hand, we got different answers for the question how often the journal writings should be conducted. All the students interviewed agree that the activity should be conducted at the end of the lessons. The reason they stated was that if the activities had been conducted at a time rather than the end of the lectures, it would have broken down their concentration to the lecture. S4 and S9 expressed their views as follows:

> It should be at the end of the lessons. Because, we loose our concentration at the end of the lessons. When the activities are distributed, we turn back to the course. (S9-EG2)

> The activity should be conducted at the end of the lessons. Because, if we do them at the beginning of the lessons, too much time will be lost and our concentration to the lesson will be hard. On the other hand, if it is conducted at the end of the lessons, it would be easier for us to concentrate on the lesson and the activity. (S4-EG1)

Students' answers related to the frequency of the activity can be grouped in five ideas. S1, S3, S8 and S9 stated that it should be after two lesson hours, S4 and S6 stated that it should be at the end of the last lesson of the week, S7 and S10 stated that it should be after each topics, S5 stated that it should be at the end of every lesson, and S5 stated that it should be rare but he did not specify an interval.

When the students were asked whether they would like to continue the journal writing activity in the future, they all agreed to continue if the timing and frequency of the journal writing were appropriate. The followings are some ideas about continuing journal writing:

> It should absolutely continue. In fact, it should be done in all the important subjects such as physics, chemistry etc. (S1-EG1)

It should continue. But, it would not be graded. (S6-EG2)

Another issue was to assess from which type of journal writings students get more benefit. As mentioned previously, two different type of journal writing-affectively oriented and cognitively oriented were given to the students. Four students (S1, S3, S7, and S10) claimed that they benefited from both types as exemplified below:

> Both the affectively and cognitively oriented journals are beneficial. Affectively oriented journals are useful because, by them we have chance to express our feelings which make me very happy. They enable us to explain our ideas directly to our teachers. On the other hand, cognitively oriented journal writings improve our point of view in mathematics. (S3-EG1)

> According to me, both of the journal types are useful. Their benefits are different. Affectively oriented journal writings let us to explain our feelings and thoughts which are difficult to tell directly. On the other hand, cognitively oriented journal writings are also very useful. They fresh our knowledge and take our attention to the lectures. (S7-EG2)

Four students (S4, S5, S8 and S9) asserted that they benefited more from cognitively oriented journal writings. Although the benefits that they pointed out were different, they have similar reasons to see the affectively oriented journal writings as redundant. S4 and S9 mentioned their feelings as follows:

> Cognitively oriented journal writings are really beneficial to me. When we do this activity, we see our deficiencies on the paper, so we have a chance to fill the gaps in our knowledge. But, the other type is not beneficial to me. They can be beneficial only to teachers. They can criticize themselves by using affectively oriented journal writings. (S4-EG1)

> Cognitively oriented journal writings are useful activities. By using them, we can analyze what we know and do not know. But, I do not understand the aim of affectively oriented journal writings. I think they are not useful for us. They maybe useful to the students who come after us. We do not see the results of our critics. (S9-EG2)

Only one student (S2) asserted that, he took advantage of only affectively oriented journal writings. The reason he stated was that, he could only answer them. Lastly, one student (S6) did not assert any idea about this issue.

4.4.2 Students' Views about Feedback in Journal Writing Activities

When the students were asked their ideas about feedback with journal writings, all of them stated that it is absolutely necessary. Their reasons were almost the same. They asserted that feedback is needed to see if their answers are right or wrong and what they should do to correct their mistakes. S3's and S8's ideas are as follows:

> Certainly, feedback should be given. Because, by them we can learn how much we answered the question and how we can correct our mistakes. (S3-EG1)

> I want feedback to be sure about my answers. If I had a mistake which I think is correct, I can compensate it by the feedback. I turn back to the topic and study again. If I do not get a feedback, I will think my answer is correct. (S8-EG2)

4.4.3 Students' Views about Grading in Journal Writing Activities

When the students were asked whether the journals should be graded, seven of them (S1, S3, S4, S5, S8, S9, and S10) stated that grading is necessary to do the activities seriously. All of these seven students asserted that they did the activities seriously but grading is necessary to make the other students do the activities seriously. S1 and S8 stated their reasons for grading as follows:

> Grading does not make any difference for me. In every situation I do the activities seriously. But, grading can be useful to take the attention of the students who do not do the activities seriously. (S1-EG1)

> Grading is not important for me. I do them seriously in any situation. But some students do not do the activities them seriously. If it is graded, those students could give attention to the activities. (S8-EG2)

S2, S6 and S7 did not want the journal writings to be graded. S6's and S7's reason was the stress caused by grading. S7 explained his opinions as follows:

> It is better if it is not graded. Because if it is graded, I will feel a pressure on me. On the other hand, when it is not graded I do the activity just for my beneficence, not for a grade. (S7-EG2)

On the other hand, S2 proposed that journal writings should not be graded, because grading can cause cheating.

CHAPTER V

DISCUSSION, CONCLUSION AND IMPLICATION

5.1 Conclusion and Discussion

The main objective of this study was to investigate the effects of journal writing with or without giving feedback and grade, compared to the traditional teaching on integral achievement of students with different learning styles. In addition, students' ideas about the journal writing activities in the mathematics classes were investigated.

The study was carried out in 2003-2004 fall semester at Atilim University. Three groups taking Calculus I course took place in this study. Two groups were randomly assigned as experimental groups (EG1 and EG2); one group was assigned as control group (CG). Expository teaching was exposed to all the groups. However, the CG students were not engaged in any journal writing activities, as was the case with the EG1 and EG2 students. Additionally, EG1 students' journal writings were graded and feedback was given.

Three instruments were used in the study: (i) Pre Test; (ii) Kolb's Learning Style Inventory; and (iii) Post Test. Pre-test and learning style inventory were administered to all groups prior to the teaching of integral. Learning style inventory results showed that the students in this study have either assimilator learning style (Type 2) or converger learning style (Type 3). Pre test results yielded that there was no statistically significant difference between the groups. Also, there was no statistically significant difference between the students having assimilator learning style and converger learning style within the groups before the instruction. On the other hand, when figure 4.1 is analyzed in details, it is seen that CG is slightly more advantageous than EG1 and EG2 before the treatment. Moreover, EG1 is slightly more advantageous than EG2 before the treatment. This little difference can be

attributable to the fact that the university entrance exam do not include grade 11 mathematics content, such as, limit, continuity, derivative, integral etc. So, very few schools give attention to those topics. But, there could be some students coming from the schools which follow the grade 11 curriculum properly and cause this difference.

To investigate the effects of treatment and learning style on students' mean scores in the post-test, ANCOVA was conducted, holding the pre-test scores as covariate. The results showed that, there were no statistically significant main effect of treatment and learning styles, and no statistically significant interaction effect of treatment and learning style. Although, there were no statistically significant differences between the groups that can be attributable to the treatment, it is seen from Table 4.1 that EG1 showed the greatest improvement. Moreover, EG2 showed greater improvement than CG. It can result from the fact that the students in this study were not very able students. They enter the university in the 20 percentile. They can be referred as low achievers and Gadzella and Baloglu (2003) stated that high achievers analyze information, retain and retrieve it better than the low achievers. On the other hand, writing helps students to practice inferring, communicating, symbolizing, organizing, interpreting, linking, explaining, planning, reflecting and acting which could be done better by high achievers. Because of that, the students did not get much benefit from the writing activities effectively. So, they could not show greater improvement than the control group. On the other hand, some can think that the difference can be attributable to the instructors. But, it does not seem to be very logical. Because, most of the students expressed positive feelings about their instructors both in affectively oriented journal writings and interviews.

ANCOVA for the post-test scores also showed that, there was no main effect of the learning styles. However, when Table 4.3 is detected, it is seen that the students having converger learning style showed more improvement than the students having assimilator learning style in both EG1 and EG2. On the other hand, in CG the students having assimilator learning style showed slightly more improvement than the students having converger learning style. So, it can be concluded that journal writing is more effective for the students having converger learning styles. It can be attributable to the fact that the students having converger learning style are best at deductive reasoning, problem solving and taking decisions (Kuri, 1998). Their main

question is “How”, so they have more tendencies in analyzing, retrieving and summarizing the information. On the other hand, the students having assimilator learning style mainly have abstract conceptualization and reflective observation learning abilities (Kolb, Boyatzis and Mainemelis, 2000). So, they mostly do few actions whle reflecting their information. Their main question is “What”, so they try to find out what they need to solve a problem. As Countryman (1992) stated writing helps student to realize what they knew and did not know; to connect prior knowledge with new studies; to summarize their knowledge; to raise questions about new concepts; to reflect on mathematics; and to construct mathematics individually. So, a student having converger learning style is more likely to benefit from writing activities.

When the students’ affectively oriented journal writings were analyzed, the common arguments identified showed that when students were asked about their feelings, they generally choose to reflect their positive and negative attitudes toward the lesson and its components (teacher, homework, quiz, language of the instruction, exam etc.). In short, they used it as a communication channel between the student and the teacher to reflect the class issues.

In the affectively oriented journal writings students also mentioned their difficulties related to integral. The students find the applications of integral (volume and area applications) as the most difficult topics. Integration techniques are another difficult topics mentioned by many students. Other topics such as integrals of logarithmic, exponential and trigonometric functions are mentioned by very few students. This can be due to the fact that, integration techniques and applications of integral need students to construct every step of solution process by themselves. On the other hand, integrals of logarithmic, exponential and trigonometric functions have rules. When a student applies the rule properly, he/she gets the result. But, in order to solve a volume problem, he/she needs to determine which method he/she will use and he/she needs to find out the integral. Then, he/she has an integral that can be solved by using integral rules.

Students’ ideas about using journal writing in math classes were investigated through semi-structured interviews. The interview results showed that most of the students benefit from the journal writings affectively and cognitively. They see the

journal writings as a communication channel between their teachers and them. They feel themselves cared about by their teachers. So, it has a therapeutic value for the students. Also, as the students write about their feelings, success, failure, incompetence etc., they start to recognize their learning, difficulties and understanding which make them participate in their learning process. This finding is also consistent with that of Borasi and Rose (1989), Shield and Galbraith (1998) and Countryman (1992) who stated that writing enhance communication between teacher and student which results in an awareness of both students and teachers about the learning process of the students. One of the students interviewed stated this as follows:

> It is a very good activity. It shows us that our teachers care about us. It also makes us analyze our knowledge. (S1-EG1)

The students also stated that they benefited from the journals cognitively. They asserted that the activity freshens their knowledge and make them aware what they know and do not know. Additionally, journal writings were claimed to show the theoretical parts of the topics and attract their attention to the lectures. These could be due to the fact that writing is more than just a means of expressing what they think; it is a means of knowing what they think- a means of shaping, clarifying, and discovering their ideas. So, they would be aware of what they know and do not know. These findings also agree with that of Countryman (1992), Bagley and Gallenberger (1992) and Miller (1992) who stated that writing helps students to realize what they knew and did not know and promotes the procedural and conceptual understanding of mathematics.

The interviewed students all agreed that the journal writing activities would be conducted at the end of lessons. The reason they stated was that if the activities had been conducted at a time rather than the end of the lessons, it would have broken down their concentration to the lectures. This could be resulted from that the students do not see the journal writing activities as a part of lessons. They may think the journal writings as an isolated activity. One of the interviewed students mentioned this as follows:

> The activity should be conducted at the end of the lessons. Because if we do them at the beginning of the lessons, too much time will be lost and our concentration to the lesson will be very hard. On the other hand, if it is conducted at the end of lessons, it would be easier for us to concentrate on the lesson and the activity.

The students also indicated that feedback is necessary for them to see whether their answers are correct or not and what they would do in order to correct that mistake. They would like to see whether their work is evaluated or not and the results of their work. This result also agrees with that of Nahrgang and Peterson (1986) and Scott, Williams and Hyslip (1992) who stated that teachers' responses to their students' journals is vital to the success of journal writing in mathematics class. One of the interviewed students stated his ideas about feedback as follows:

> I want feedback to be sure about my answers. If I had mistake which I think is correct, I can compensate it by the feedback. I turn back to the topic and study again. If I do not get a feedback, I will think as my answer is correct.

Lastly, most of the students interviewed asserted that grading is necessary to do the activities seriously. This shows that students need a reason like grading for completing the journals. Similarly, Chapman (1996) stated that when the journal writings worth more in the final grade, students become more actively engaged in the spirit of the journal writing. The finding also agrees with that of Talman (1990), who reported that students give more attention if journal writings are graded. On the other hand, few students stated that journal writings should not be graded. Their reasons were that grading can cause cheating and stress. This can result from that if the journal writings are graded, they see the journal writings as an exam which most of the time cause stress. On the other hand, expressing cheating can be an indicator of that the students have a tendency to cheat when it is graded.

5.2 Implications of the Study

Based on the findings of the study and literature review, following suggestions can be offered:

1. Before the semester starts, the students' learning styles would be determined and the sections would be grouped according to the students' learning styles.
2. Class activities would be conducted according to the students' learning styles. The activities would be changeable according to the learning styles of students.
3. Students' level of understanding would be determined before the instruction starts. So, teachers have a change to design the lectures according to the level of students.
4. Since writing in mathematics is not a usual activity, students should be conducted in warm up writing activities before the actual journal writings start.
5. Students should be informed about the journal writing activities before they start to write. Also, they should be convinced about the importance of the activity.
6. Teachers need time to collaborate, develop and expand their instructional methods to insure that their lessons are appropriate for all students.
7. Teachers also need extra time to evaluate and give feedback daily journals. Because of that, some precautions should be taken.

5.3 Suggestions for Further Study

In order to gain more evidence on the effect of using journal writing in the mathematics classes, the following studies are offered:

1. To see the effects of journal writing on different learning styles, construct four classes according to the students learning styles. Then, use journal writing in each group and investigate which group is benefited more than the others.
2. To see whether journal writing is more affective on high achiever students than low achiever students, two groups would be used. One group would have high achievers and the other group would have low achievers. Then, journal writing is conducted and its effects are investigated.
3. To see if the timing of the journal writing affects the mathematics learning, use journal writings in three different classes. In the first class,

journal writing is used only at the end of the class. In the second one journal writing is used only at the beginning of the class, and in the third one the use of journal writing is varying according to the lesson.

4. To see if the type of teaching affects the impact of journal writing on mathematics lesson. For example, four different classes can be used. Two of them are taught by cooperative learning and two of them are taught by constructivist teaching method. One of the classes in the cooperative learning group and constructivist teaching group also engages in journal writing activities. At the end, the difference of two journal writing groups can be investigated.
5. To see whether convincing students about the importance and necessity of journal writing affects the mathematics learning. Using four different classes is necessary for this kind of research. First class is started to use journals without any explanations. The second one only provided oral explanations before using journals. The third class is given information sheets before starting to use journal writings. The last class is used both oral explanations and information sheets before starting to use journal writings.
6. Sample size of a further research could be increased to obtain more accurate results.

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APPENDIX A

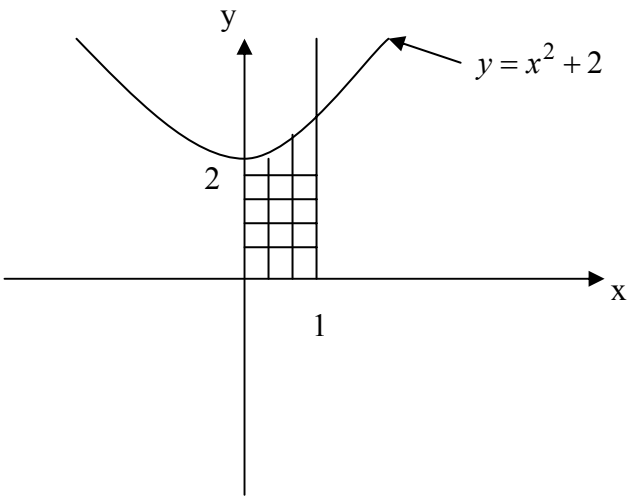
PRE TEST

Name:
Surname:

1. What is an integral? Define and explain as much as possible.
2. Evaluate the following intagrals,

a) $\int (x^3 - \sqrt{x})dx$ b) $\int \frac{dx}{(3x+5)^2}$ c) $\int \frac{dz}{2z+7}$ d) $\int xe^x dx$

3. Find the area of the shaded region below,



4. Find the volume of the solid generated by rotating the area bounded by $y = -x + 1$, $x = 0$ and $y = 0$ about the x-axis.

APPENDIX B

POST TEST

Name:
Surname:
Section:
Date: 22.12.2003
University Entrance Score:

1) If $f(x) = x + g(x)$ and $g(x) = \int_2^x \frac{t}{3+t^8}$, find $f'(2)$.

2) If the derivative of the function $f(x)$ is given as $g(x)$ $\frac{d}{dx}(f(x)) = g(x)$ can we say anything about the integral of $g(x)$ $\int g(x)d(x)$? Explain your answer as much as possible.

3) Can a function have more than one antiderivative? If so, how are the antiderivatives related? Explain your answer as much as possible and give an example.

4) Which one(s) of the followings can be the total area of the region between the graph of $f(x) = \sin(x)$ where $0 \le x \le 2\pi$ and x-axis. Write down your choice(s) and explain why it/they is/are the right integral(s).

a) $\int_0^{2\pi} \sin(x)d(x)$ **b)** $\int_0^{2\pi} |\sin(x)|d(x)$ **c)** $\int_0^{\pi} \sin(x)d(x) - \int_{\pi}^{2\pi} \sin(x)d(x)$

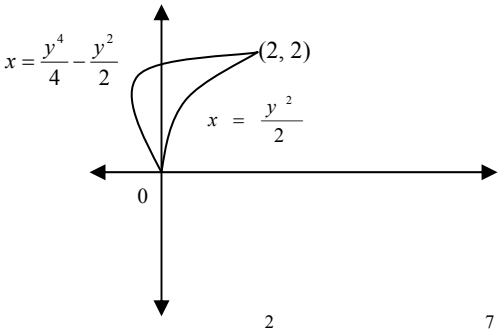
d) $2\int_0^{\pi} \sin(x)d(x)$

5) How do you define and calculate the length of a curve which is the graph of a smooth function $y = f(x)$ over a closed interval $[a,b]$. Give an example.

6) The region here is to be revolved about the x-axis to generate a solid. Write down the integrals to compute the volume of the solid by

- **a)** Washer method
- **b)** Shell method

Which one do you think is the best method to evaluate the volume of the solid? Explain your answer as much as possible. **(Do not evaluate the integrals)**



7) Suppose that $\int_{-2}^{2} f(x)d(x) = 5$, $\int_{2}^{7} f(x)d(x) = 9$ and $\int_{-2}^{7} g(x)d(x) = 2$ which, if any, of the following statements that are always true, which ones are false? Explain your answers as much as possible.

a) $\int_{7}^{2} f(x)d(x) = -9$ **b)** $\int_{-2}^{7} f(x)d(x) = 4$ **c)** $\int_{-2}^{7} f(x)g(x)d(x) = 28$

d) $\int_{-2}^{7} 4g(x)d(x) = 16$ **e)** $\int_{2}^{7} f(2x+1)d(2x+1) = 9$ **f)** $\int_{-2}^{7} g(u)d(u) = 2$

APPENDIX C

ÖĞRENME STİLİ ENVANTERİ

Ad:
Soyad:
Cinsiyet: K( ) E( )

Sevgili öğrenci,

Aşağıda her birinde dörder cümle bulunan on iki durum verilmektedir.Her durum için size en uygun olan cümleye 4 puan, ikinci uygun olana 3 puan, üçüncü uygun olana 2 puan, en az uygun olana ise 1 puan olarak ilgili cümlenin başındaki boşluğa yazınız. Bu envanter, sizin matematik dersine çalışırken veya öğrenirken hangi öğrenme stiline sahip olduğunuzu tespit ederek, matematik dersinde size uygun bir öğretim modeli belirlemek amacıyla sunulmuştur. Lütfen cümlelerin başındaki boşlukları en uygun şekilde doldurunuz.

****
* **Hatırlamanız için:** *
* **(4) size en uygun olan** *
* **(3) size ikinci en uygun olan** *
* **(2) size üçüncü en uygun olan** *
* **(1) size en az uygun olan** *
****

1. Öğrenirken

( ) duygularımı göz önüne almaktan hoşlanırım.
( ) izlemekten hoşlanırım.
( ) fikirler üzerine düşünmekten hoşlanırım.
( ) bir şeyler yapmaktan hoşlanırım.

2. En iyi

( ) duygularıma ve önsezilerime güvendiğimde
( ) dikkatlice dinlediğim ve izlediğimde
( ) mantıksal düşünmeyi temel aldığımda
( ) bir şeyler elde etmek için çok çalıştığımda öğrenirim.

3. Öğrenirken

( ) güçlü duygu ve tepkilerle dolu olurum
( ) sessiz ve çekingen olurum.
( ) sonuçları bulmaya yönelirim.
( ) yapılanlardan sorumlu olurum.

4.

( ) Duygularımla
( ) İzleyerek
( ) Düşünerek
( ) Yaparak
öğrenirim.

5.

( ) Yeni deneyimlere açık olurum.
( ) Konunun her yönüne bakarım.
( ) Analiz etmekten ve onları parçalara ayırmaktan hoşlanırım.
( ) Denemekten hoşlanırım.

6. Öğrenirken

( ) sezgisel
( ) gözleyen.
( ) mantıklı
( ) hareketli
biriyim.

7. En iyi

( ) kişisel ilişkilerden
( ) gözlemlerden
( ) akılcı kuramlardan
( ) uygulama ve denemelerden
öğrenirim.

8. Öğrenirken

( ) kişisel olarak o işin bir parçası olurum.
( ) işleri yapmak için acele etmem.
( ) kuram ve fikirlerden hoşlanırım.
( ) çalışmamdaki sonuçları görmekten hoşlanırım.

9. En iyi

( ) duygularıma dayandığım zaman
( ) gözlerime dayandığım zaman
( ) fikirlerime dayandığım zaman
( ) öğrendiklerimi uyguladığım zaman
öğrenirim.

10. Öğrenirken

( ) kabul eden
( ) çekingen
( ) akılcı
( ) sorumlu
biriyim.

11. Öğrenirken

( ) katılırım.
( ) gözlemekten hoşlanırım.
( ) değerlendiririm.
( ) aktif olamaktan hoşlanırım.

12. En iyi

( ) akılcı ve açık fikirli olduğum zaman
( ) dikkatli olduğum zaman
( ) fikirleri analiz ettiğim zaman
( ) pratik olduğum zaman öğrenirim.

Buradan aşağıyı boş bırakınız

SY: **YG:** **SK:** **AY:**

SK-SY:

AY-YG:

APPENDIX D

JOURNAL WRITINGS

JOURNAL WRITING # 1

Name :
Surname :
Date : 19.11.2003
Üniversite Giriş Puanı:

Topic: What did you learn about the integral concept in this lesson? Clarify your answer by using as many ways as you can (you can use vebal explanation, charts , examples, tables...).

JOURNAL WRITING # 2

Name :
Surname :
Date : 19.11.2003
Üniversite Giriş Puanı:

Free Writing: What do you feel about the course, considering the type of teaching, homeworks, quizes, recitation hours, exams...etc. Explain your answers as much as possible.

JOURNAL WRITING # 3

Name :
Suranme :
Date : 1.12.2003

Prompt: If the following equality is given,

$$\int x^2\cos(2x)dx=\frac{1}{2}x\cos(2x)+\frac{1}{4}(-1+2x^2)\sin(2x)+C$$

How can you check its correctness? Please check if it is true or false? Explain your answer.

JOURNAL WRITING # 4

Name :
Surname :
Date : 3.12.2003

Prompt: Evaluate the following integral, $\int \cos(x^2) d(x^2)$

JOURNAL WRITING # 5

Name :
Surname :
Date : 8.12.2003

Prompt: Answer the following questions,

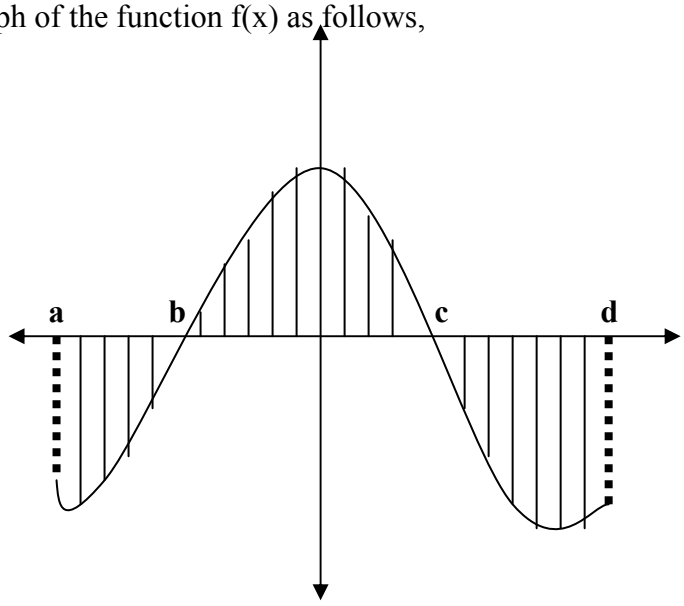
a) We can differentiate an integral by……(Theorem).

b) Find the derivative of $\int_0^1 [x^3 2^x Cos(x+7)]dx$. Explain your answer as much as possible.

JOURNAL WRITING # 6

Name :
Surname:
Date :10.12.2003

Prompt: Given the graph of the function f(x) as follows,



The area between the fuction f(x) and the x-axis equals to

a) $A = \int_a^d f(x)d(x)$

b) $A = \int_a^b f(x)d(x) - \int_b^c f(x)d(x) + \int_c^d f(x)d(x)$

c) $A = \int_a^b f(x)d(x) + \int_b^c f(x)d(x) - \int_c^d f(x)d(x)$

d) $A = -\int_a^b f(x)d(x) + \int_b^c f(x)d(x) - \int_c^d f(x)d(x)$

<u>Explain your answer as much as possible.</u>

JOURNAL WRITING # 7

Name :
Surname:
Date :15.12.2003

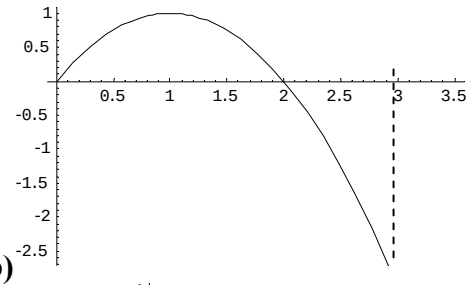
Prompt: What kind of difficulties you have experienced about the integral topic. According to you, what are the most difficult parts of integral topic? Explain as much as possible (you can use vebal explanations, diagrams, tables, examples….any way you want).

JOURNAL WRITING # 8

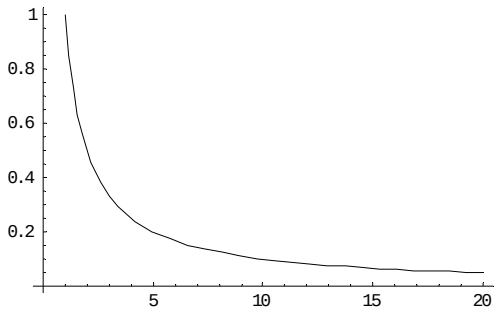
Name :
Surname:
Date :15.12.2003

Prompt: When the shaded regions below are rotated through 360° about x-axis, a solid is traced out.

a)



b)



If possible, write down the integral formulas for the volumes of the above solids. If it is not possible , explain why not?

JOURNAL WRITING # 9

Name :
Surname:
Date :17.12.2003

Prompt: List all of the mistakes that you have made in class, on homeworks, on quizes and on activities about the integral concept.

JOURNAL WRITING # 10

Name :
Surname:
Date :17.12.2003

Prompt: Write down (construct) an integral in which

a) Integration by parts **b)** Partial fraction **c)** Trigonometric substutition

method should be used to evaluate the integral. (**Do not evaluate the integrals)**

JOURNAL WRITING # 11

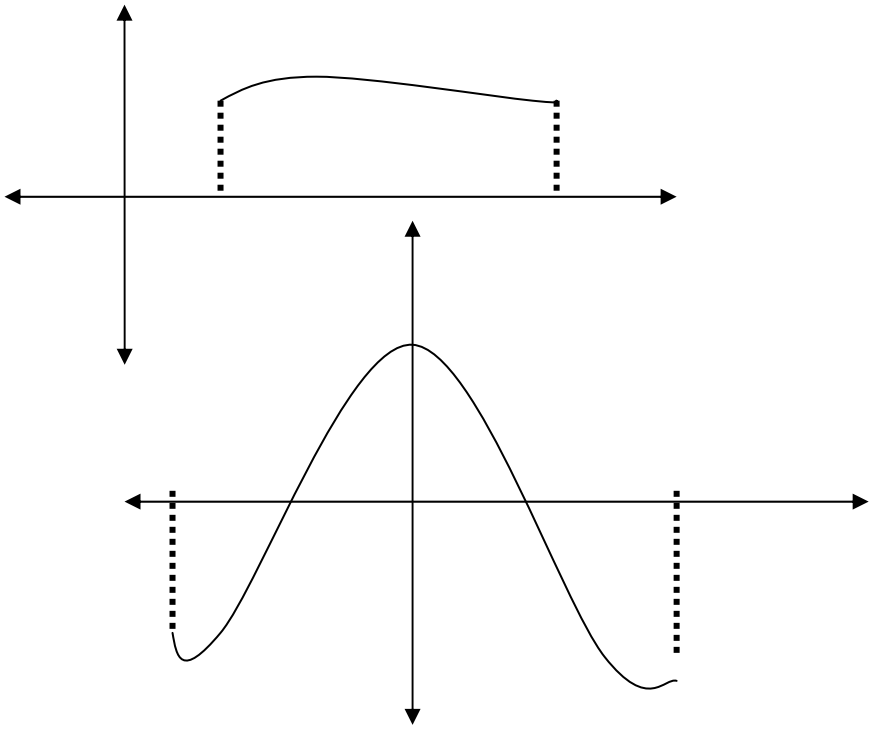
Name :
Surname:
Date :22.12.2003

Prompt: After the second exam, evaluate your exam and write down the RIGHTS and WRONGS while you were working for the exam and attending to lectures.
If you had a second chace to take the exam, what would you do different from this?

JOURNAL WRITING # 12

Name :
Surname:
Date :22.12.2003

Prompt: Here are two curves,



Can we evaluate the lenghts of these two curves? If yes, write down the formulas for the lenghts of the curves? Explain your answer as much as possible.

a)

b)

JOURNAL WRITING # 13

Name :
Surname:
Date :24.12.2003

Prompt: Write down all the things that you feel about

The Course:

Teaching:

Quizes:

Homeworks:

Recitation Hours:

JOURNAL WRITING # 14

Name :
Surname:
Date :24.12.2003

Prompt: If $\int_0^1 f(x)d(x) = 4$ and $f(x) \geq 0$, does $\int_0^1 \sqrt{f(x)}d(x) = \sqrt{4} = 2$ hold?
Explain your answer as much as possible.

APPENDIX E
EXAMPLES OF STUDENTS' RESPONSES AND FREQUENCIES FOR EACH ITEM IN THE PRE-TEST

Item 1
What is an integral? Define and explain as much as possible.

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Answers containing main ideas concerned with area or derivative. (e.g. Integration is the process to evaluate the area under a curve.)	0	0	4 (15%)
3	Answers containing main ideas concerned with the area or derivative. (e.g. Integration is the opposite process of differentiation).	14 (44%)	18 (64%)	16 (59%)
2	Answers containing an isolated correct fact. (e.g. Integration is a total, it refers to totality).	5 (16%)	0	1 (4%)
1	No understanding of the integral concept. (e.g. Integral is the "$\int$ " symbol).	4 (13%)	0	1(4%)
0	"Do not know" or missed.	9 (21%)	10 (36%)	5 (19%)

Item 2 Evaluate the following integrals

2(a) $\int (x^3 - \sqrt{x})dx$

Score	RESPONSE	EG1	EG2	CG
5	Correct answer or wrong answer due to trivial arithmetical errors overlooked (e.g. $\int (x^3 - \sqrt{x})dx = \frac{x^4}{4} - \frac{2x^{3/2}}{3} + C$).	1 (3%)	3 (11%)	2 (7%)
4	Evaluating an antiderivative instead of integral (e.g. $\int (x^3 - \sqrt{x})dx = \frac{x^4}{4} - \frac{2x^{3/2}}{3}$).	4 (13%)	2 (7%)	3 (11%)
3	Partly correct integration (e.g. $\int (x^3 - \sqrt{x})dx = \frac{x^4}{4} - x^{3/2} + C$).	14 (44%)	0	1 (4%)
2	Relevant ideas to integration rules (e.g. $\int (x^3 - \sqrt{x})dx = x^4 - x^{3/2} + C$).	0	0	2 (7%)
1	Totally wrong answers (e.g. $\int (x^3 - \sqrt{x})dx = 3x^2 - x^{1/2} + C$).	6 (19%)	0	3 (11%)
0	"Do not know" or missed.	20 (63%)	23 (82%)	16 (59%)

2(b) $\int \frac{dx}{(3x+5)^2}$

Score	RESPONSE	EG1	EG2	CG
5	Correct answer or wrong answer due to trivial arithmetical errors overlooked (e.g. $\int \frac{dx}{(3x+5)^2}$, Let's $3x+5=u$, $3dx=du \Rightarrow \frac{1}{3}\int \frac{du}{(u)^2}=\frac{-1}{3u}+C$).	0	1 (4%)	0
4	Correct substitution but incorrect integration (e.g. $\int \frac{dx}{(3x+5)^2}$, Let's $3x+5=u$, $3dx=du \Rightarrow \frac{1}{3}\int \frac{du}{(u)^2}=\frac{1}{3}\frac{(u)^3}{3}+C$).	2 (6%)	0	0
3	Incorrect application of power rule for integration(e.g. $\int \frac{dx}{(3x+5)^2}=\frac{(3x+5)^{-1}}{-1}+C$)	1 (3%)	2 (7%)	2 (7%)
2	(n/a)	0	0	0
1	Totally wrong answers (e.g. $\int \frac{dx}{(3x+5)^2}=\int (3x+5)^{-2}dx=\frac{1}{3x+5}\frac{-1}{2}+C$).	2 (6%)	1 (4%)	6 (22%)
0	"Do not know" or missed.	27 (84%)	24 (86%)	19 (70%)

2(c) $\int \frac{dz}{2z+7}$

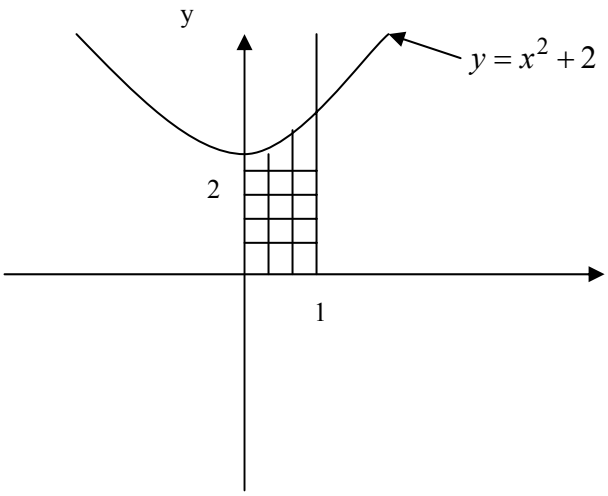
Score	RESPONSE	EG1	EG2	CG
5	Correct answer or wrong answer due to trivial arithmetical errors (e.g. $\int \frac{dz}{2z+7}$, $2z+7=u, 2dz=du \Rightarrow \int \frac{\frac{1}{2}du}{u}=\frac{1}{2}\ln\lvert u\rvert+C$	2 (6%)	0	0
4	Correct integration but missing absolute value (e.g. $\int \frac{dz}{2z+7}$, $2z+7=u, 2dz=du \Rightarrow \int \frac{\frac{1}{2}du}{u}=\frac{1}{2}\ln u+C$	0	1 (4%)	0
3	(n/a)	0	0	0
2	Incorrect application of power rule for integration.(e.g. $\int \frac{dz}{2z+7}=\frac{(2z+7)^0}{0}+C$).	1 (3%)	1 (4%)	0
1	Totally wrong answers (e.g. $\int \frac{dz}{2z+7}=1+C$).	2 (6%)	1 (4%)	6 (22%)
0	"Do not know" or missed.	27 (84%)	25 (89%)	21 (78%)

2(d) $\int xe^x dx$

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Correct method but incomplete result (e.g. $\int xe^x dx$, $x = u \Rightarrow dx = du$, $e^x dx = dv \Rightarrow e^x = v$, $\int xe^x dx = xe^x - \int e^x dx$).	2 (6%)	0	2 (7%)
3	(n/a)	0	0	0
2	(n/a)	0	0	0
1	Totally wrong answers (e.g. $\int xe^x dx = \frac{x^2}{2} \ln x$).	2 (6%)	0	0
0	"Do not know" or missed.	28 (88%)	28 (100%)	22 (82%)

Item 3

Find the area of the shaded region below,



Score	RESPONSE	EG1	EG2	CG
5	Totally correct answer (e.g. $\int_0^1 (x^2+2)dx = \left(\frac{x^3}{3}+2x\right]_0^1 = \frac{7}{3}$).	1 (3%)	1 (4%)	2 (7%)
4	Correct integral formula but no result or wrong result (e.g. $\int_0^1 (x^2+2)dx$).	1 (3%)	0	1 (4%)
3	Correct integrand but incorrect boundaries (e.g. $\int_1^2 (x^2+2)dx = \left(\frac{x^3}{3}+2x\right]_1^2 = \frac{13}{3}$).	3 (9%)	3 (11%)	5 (19%)
2	(n/a)	0	0	0
1	Totally wrong answers (e.g. $\int_1^2 2dx$).	3 (9%)	0	1 (4%)
0	"Do not know" or missed.	24 (75%)	24 (86%)	18 (67%)

Item 4

Find the volume of the solid generated by rotating the area bounded by $y = -x+1$, $x = 0$ and $y = 0$ about the x-axis.

Score	RESPONSE	EG1	EG2	CG
5	Answers containing right explanation and example (e.g. A function can have more than one antiderivative which differs by a constant. For example the antiderivative of x^2 is $\frac{x^3}{3}$, $\frac{x^3}{3}+1$, $\frac{x^3}{3}-1$ ... which differ from $\frac{x^3}{3}$ by a constant).	1 (3%)	2 (7%)	2 (7%)
4	Answers containing right explanation without an example (e.g. Yes a function can have more than one antiderivative which differs by a constant c).	4 (13%)	1 (4%)	1 (4%)
3	(n/a)	0	0	0
2	Answers containing some related ideas or some unrelated facts (e.g. Differentiation and integration are the opposite actions. OR, Yes it can if the function is continuous).	12 (38%)	7 (25%)	7 (25%)
1	Totally wrong answers (e.g. $\lim_{x\to a} \frac{f(a)+f'(a)}{x-a}$).	6 (19%)	8 (29%)	3 (11%)
0	"Do not know" or missed.	8 (28%)	10 (36%)	13 (48%)

APPENDIX F
EXAMPLES OF STUDENTS' RESPONSES AND FREQUENCIES FOR EACH ITEM IN THE POST-TEST

Item 1

If $f(x) = x + g(x)$ and $g(x) = \int_2^x \frac{t}{3+t^8}$, find $f'(2)$.

Score	RESPONSE	EG1	EG2	CG
5	Totally correct answers (e.g. $f(x) = x + g(x) \Rightarrow f'(x) = 1 + g'(x)$; $g'(x) = \frac{d}{dx}\left(\int_2^x \frac{t}{3+t^8}dt\right) = \frac{x}{3+x^8}$ $\Rightarrow f'(x) = 1 + \frac{x}{3+x^8}$ $f'(2) = 1 + \frac{2}{3+2^8} = \frac{261}{259}$)	4 (13%)	3 (11%)	8 (30%)
4	(n/a)	0	0	0
3	Answers containing important ideas but not the exact solution (e.g. $f(x) = x + g(x) \Rightarrow f'(x) = 1 + g'(x)$ and $g'(x) = \frac{d}{dx}\left(\int_2^x \frac{t}{3+t^8}dt\right) = \frac{x}{3+x^8} - \frac{2}{3+2^8}$).	4 (13%)	0	0
2	Answers containing related ideas with a solution (e.g. $f(x) = x + g(x) \Rightarrow f'(x) = 1 + g'(x)$ and $g'(x) = \frac{(3+x^8) - 8x^8}{(3+x^8)^2}$; $f'(x) = 1 + \frac{-7x^8 + 3}{(3+x^8)^2} \Rightarrow f'(2) = 1 + \frac{-7.2^8 + 3}{(3+2^8)^2}$).	11 (34%)	8 (29%)	3 (11%)
1	Totally wrong answers (e.g. $f(2) = 2 + g(2) \Rightarrow f'(2) = 0$)	8 (25%)	13 (46%)	11 (41%)
0	"Do not know" or missed.	5 (16%)	4 (14%)	5 (19%)

Item 2

If the derivative of the function $f(x)$ is given as $g(x)$ [$\frac{d}{dx}(f(x)) = g(x)$] can we say anything about the integral of $g(x)$ [$\int g(x)d(x)$]? Explain your answer as much as possible.

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Correct answer but not a completely right explanation (e.g. $\int g(x)dx = f(x)$ since $f'(x) = g(x) \Rightarrow f(x)$ is an antiderivative of $g(x)$).	1 (3%)	2 (7%)	1 (4%)
3	Answers containing some related ideas (e.g. $\int g(x)dx = f(x)$ since integration is the opposite of derivative).	4 (13%)	1 (4%)	9 (33%)
2	Answers containing only some related statements or examples (e.g. $f(x) = x^3 \Rightarrow 3x^2 = g(x) \Rightarrow \int g(x)dx = \int 3x^2 dx = x^3$	20 (63%)	8 (29%)	6 (22%)
1	Totally wrong answers (e.g. A function's derivative equals to the functions integral).	2 (6%)	5 (18%)	3 (11%)
0	"Do not know" or missed.	5 (16%)	12 (43%)	8 (30%)

Item 3

Can a function have more than one antiderivative? If so, how are the antiderivatives related? Explain your answer as much as possible and give an example.

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Correct method but incomplete result (e.g. $\int xe^x dx$, $x = u \Rightarrow dx = du$, $e^x dx = dv \Rightarrow e^x = v$, $\int xe^x dx = xe^x - \int e^x dx$).	2 (6%)	0	2 (7%)
3	(n/a)	0	0	0
2	(n/a)	0	0	0
1	Totally wrong answers (e.g. $\int xe^x dx = \frac{x^2}{2}\ln x$).	2 (6%)	0	0
0	"Do not know" or missed.	28 (88%)	28 (100 %)	22 (82%)

Item 4

Which one(s) of the followings can be the total area of the region between the graph of $f(x) = \sin(x)$ where $0 \le x \le 2\pi$ and x-axis. Write down your choice(s) and explain why it/they is/are the right integral(s).

4(a) $\int_0^{2\pi} \sin(x)d(x)$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement-False and correct explanation (e.g. A is false; because the function $\sin x$ has negative value on $[\pi, 2\pi]$ so the given integral can not give the true area).	0	0	1 (4%)
4	(n/a)	0	0	0
3	Answers containing correct statement-False and some related explanation (e.g. A is false because the integral sign changes between $\left[\pi, \frac{3\pi}{2}\right]$ and $\left[\frac{3\pi}{2}, 2\pi\right]$).	1 (3%)	0	0
2	Answers containing correct statement-False but incorrect explanation or no explanation (e.g. False, because different solution).	6 (19%)	6 (21%)	6 (21%)
1	Totally wrong answers (e.g. True, area does not change).	9 (28%)	13 (46%)	13 (46%)
0	"Do not know" or missed.	16 (50%)	9 (32%)	12 (44%)

4(b) $\int_0^{2\pi} |\sin(x)| d(x)$

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Answers containing correct statement-True and indicating good explanation but reasoning is not complete (e.g. True, because in $[\pi, 2\pi]$ $\sin x$ changes its value so it must be $\int_0^{2\pi} \lvert\sin x\rvert dx$ or $\int_0^{\pi} \sin x dx - \int_{\pi}^{2\pi} \sin x dx$).	1 (3%)	0	1 (4%)
3	Answers containing correct statement and some related explanations (e.g. True, because it is between $[0, 2\pi]$ and because of the absolute value x will be always greater than zero).	1 (3%)	0	1 (4%)
2	Answers containing correct statement but incorrect or no explanation (e.g. True but no need the absolute value).	5 (16%)	8 (29%)	6 (22%)
1	Totally wrong answers (e.g. False, because it is just only positive values. So, it is not the total area).	10 (31%)	10 (36%)	11 (41%)
0	"Do not know" or missed.	15 (47%)	10 (36%)	11 (41%)

4(c) $\int_0^{\pi} \sin(x)d(x)$ - $\int_{\pi}^{2\pi} \sin(x)d(x)$

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Answers containing correct statement-True and indicating good explanation but reasoning is not complete (e.g. True, because when we are calculating an area which is under x-axis should be minus).	2 (6%)	0	1 (4%)
3	Answers containing correct statement and some related explanations (e.g. True, because the area is $\int_0^{\pi} \sin x dx + \int_{\pi}^{\pi/2} -\sin x dx + \int_{\pi/2}^{2\pi} -\sin x dx$)	1 (3%)	0	2 (7%)
2	Answers containing correct statement but incorrect or no explanation (e.g. True, because it has boundaries).	13 (41%)	12 (43%)	5 (19%)
1	Totally wrong answers (e.g. False, it should be the sum of two integrals).	9 (28%)	9 (32%)	10 (37%)
0	"Do not know" or missed.	7 (22%)	7 (25%)	9 (33%)

4(d) $2\int_0^{\pi} \sin(x)d(x)$

Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Answers containing correct statement-True and indicating good explanation but reasoning is not complete (e.g. True, because the area between $[0,\pi]$ and $[\pi,2\pi]$ are the same).	1 (3%)	0	0
3	(n/a)	0	0	0
2	Answers containing correct statement but incorrect or no explanation (e.g. True, because it is the same with $\int_0^{2\pi} \sin x dx$).	1 (3%)	8 (29%)	2 (7%)
1	Totally wrong answers (e.g. False, because it is just only positive values. So, it is not the total area).	14 (44%)	10 (36%)	9 (33%)
0	"Do not know" or missed.	16 (50%)	10 (36%)	16 (59%)

Item 5

How do you define and calculate the length of the graph of a smooth function $y = f(x)$ over a closed interval $[a,b]$. Give an example.

Score	RESPONSE	EG1	EG2	CG
5	Answers containing the correct formula and example (e.g. The length can be evaluated by $L = \int_a^b \sqrt{1+[f'(x)]^2}\,dx$, for example we can evaluate the length of the curve $y = x^2$ where 2<x<3 by the integral $L = \int_a^b \sqrt{1+(2x)^2}\,dx$	3 (9%)	0	1 (4 %)
4	(n/a)	0	0	0
3	Answers containing correct formula or incorrect formula due to wrong formula (e.g. $L = \int_a^b \sqrt{1+[f(x)]^2}\,dx$, let $f(x) = x^2 \Rightarrow L = \int_a^b \sqrt{1+(x^2)^2}\,dx$).	10 (31%)	0	0
2	Answers containing wrong but some related formulas (e.g. $L = \int_a^b \sqrt{1+(\frac{dx}{dy})^2}$).	3 (9%)	4 (13%)	4 (15 %)
1	Totally wrong answers (e.g. $L = \int_a^b \sqrt{1+(\frac{1}{f'(x)})^2}$)	8 (25%)	9 (32%)	9 (33 %)
0	"Do not know" or missed.	8 (25%)	15 (54%)	13 (48 %)

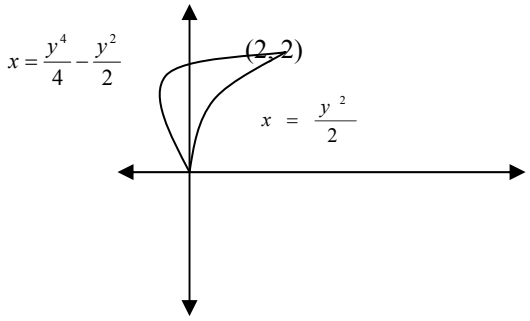
Item 6

The region here is to be revolved about the x-axis to generate a solid. Write down the integrals to compute the volume of the solid by

c) Washer method

d) Shell method

Which one do you think is the best method to evaluate the volume of the solid? Explain your answer as much as possible. **(Do not evaluate the integrals)**



Score	RESPONSE	EG1	EG2	CG
5	(n/a)	0	0	0
4	Answers containing right explanations about the washer and shell method, and stating shell method is more suitable than the washer method (e.g. In washer method we take a rectangular piece perpendicular to x-axis and we have to find the y as a function of x. In shell method, we take a cylinder parallel to x-axis. Shell method is easier, because the variables are in terms of y).	1 (3%)	0	0
3	Answers containing related explanations about washer method, and stating shell method is better to use for that example. (e.g. In washer method, we use perpendicular rectangles, in shell method we use cylinders, shell method is better to use).	1 (3%)	0	0
2	Answers stating that shell method is better but no explanation about washer method, and wrong or no verification of shell method (e.g. Shell method is better, because it can turn round the y-axis and make a solid, we can calculate like that).	8 (25%)	8 (29%)	3 (11%)
1	Totally wrong answers (e.g. $V = \int_{-1/4}^{0} (\frac{y^4}{4} - \frac{y^2}{2})dy - \int_{0}^{2} \frac{y^2}{2})$	9 (28%)	6 (21%)	12 (44%)
0	"Do not know" or missed.	13 (41%)	14 (50%)	12 (44%)

Item 7

Suppose that $\int_{-2}^{2} f(x)d(x) = 5$, $\int_{2}^{7} f(x)d(x) = 9$ and $\int_{-2}^{7} g(x)d(x) = 2$ which, if any, of the following statements that are always true, which ones are false? Explain your answers as much as possible.

7(a) $\int_{7}^{2} f(x)d(x) = -9$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement and correct explanation (e.g. A is true, because $\int_{a}^{b} f(x)dx = -\int_{b}^{a} f(x)dx$)	10 (31%)	9 (32%)	5 (19%)
4	(n/a)	0	0	0
3	Answers containing correct statement but incomplete explanation (e.g. A is true, because we should reverse the integral).	2 (6%)	1 (4%)	1 (4%)
2	Answers containing correct statement but incorrect or no explanation (e.g. A is true, because f(7)-f(2)=-[f(2)-f(7)])	8 (25%)	8 (29%)	19 (70%)
1	Totally wrong answers (e.g. False, it can be different because f(x) is unknown).	7 (22%)	4 (14%)	0
0	"Do not know" or missed.	5 (16%)	6 (21%)	2 (7%)

7(b) $\int_{-2}^{7} f(x)d(x) = 4$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement and correct explanation (e.g. B is false, because $\int_{-2}^{7} f(x)dx = \int_{-2}^{2} f(x)dx + \int_{2}^{7} f(x)dx = 5+9 = 14$).	6 (19%)	2 (7%)	4 (15%)
4	(n/a)	0	0	0
3	Answers containing correct statement but incomplete explanation (e.g. B is false because 9+5=14).	1 (3%)	2 (7%)	2 (7%)
2	Answers containing correct statement but incorrect or no explanation (e.g. B is false, because it is 8).	11 (34%)	13 (46%)	12 (44%)
1	Totally wrong answers (e.g. It is true because $\int_{-2}^{7} g(x)dx = 2$, $g(x)$ is different from $f(x)$).	6 (19%)	5 (18%)	4 (15%)
0	"Do not know" or missed.	8 (15%)	6 (21%)	5 (19%)

7(c) $\int_{-2}^{7} f(x)g(x)d(x) = 28$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement and correct explanation (e.g. C is false, because we can not know it without knowing f(x) and g(x)).	2 (6%)	0	0
4	Answers containing the correct statement and including main idea with some evidence of knowledge (e.g. False because $\int_a^b (f(x).g(x))dx \neq \int_a^b f(x)dx.\int_a^b g(x)dx$).	4 (13%)	0	1 (4%)
3	Answers containing correct statement and some related explanations (e.g. C is false, because if we take $f(x) = x$ and $g(x) = x + 2$ then $f(x).g(x) = x^2 + 2x$ and if we compute it we get different answer).	0	1 (4%)	3 (11%)
2	Answers containing correct statement but incorrect or no explanation (e.g. C is false, because it is 18).	9 (28%)	12 (43%)	7 (26%)
1	Totally wrong answers (e.g. It is true because, $\int_{-2}^{7} f(x)dx = 14$, $\int_{-2}^{7} g(x)dx = 2 \Rightarrow \int_{-2}^{7} f(x).g(x)dx = 2.14 = 28$	7 (22%)	7 (25%)	7 (26%)
0	"Do not know" or missed.	10 (31%)	8 (29%)	9 (33%)

7(d) $\int_{-2}^{7} 4g(x)d(x) = 16$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement and correct explanation (e.g. D is false, because $\int_{-2}^{7} 4g(x)dx = 4\int_{-2}^{7} g(x)dx = 8 \neq 16$)	12 (38%)	9 (32%)	12 (44%)
4	(n/a)	0	0	0
3	Answers containing correct statement and some related explanations (e.g. D is false, because the answer should be 8).	3 (9%)	1 (4%)	3 (11%)
2	Answers containing correct statement but incorrect or no explanation (e.g. D is false, because the function whose coefficient 4 does not give that answer).	4 (13%)	7 (25%)	4 (15%)
1	Totally wrong answers (e.g. True, It should be 16).	6 (19%)	7 (25%)	3 (11%)
0	"Do not know" or missed.	7 (22%)	4 (14%)	5 (19%)

7(e) $\int_{2}^{7} f(2x+1)d(2x+1) = 9$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement and correct explanation (e.g. E is true, because if we call $u = 2x+1$, $\int_{2}^{7} f(u)du = 9$, nothing changes).	1 (3%)	2 (7%)	2 (7%)
4	Answers containing correct statement and including main idea with some evidence of knowledge (e.g. E is true, because, $\int_{2}^{7}$ f(2x+1)d(2x+1) → These are the same).	3 (9%)	2 (7%)	3 (11%)
3	Answers containing correct statement and some related explanations (e.g. E is true, because for d(2x+1) if it were d(x) it would be false).	2 (6%)	3 (11%)	0
2	Answers containing correct statement but incorrect or no explanation (e.g. E is true, because if we multiply by 2 and add 1, nothing change).	4 (13%)	7 (25%)	4 (15%)
1	Totally wrong answers (e.g. False, because f(x) and f(2x+1) are different functions).	8 (25%)	6 (21%)	9 (33%)
0	"Do not know" or missed.	9 (28%)	8 (29%)	8 (30%)

7(f) $\int_{-2}^{7} g(u)d(u) = 2$

Score	RESPONSE	EG1	EG2	CG
5	Answers containing correct statement and correct explanation (e.g. F is true, because if we call $u = x$, then dx=du so nothing changes in integral).	1 (3%)	0	1 (4%)
4	Answers containing correct statement and including main idea with some evidence of knowledge (e.g. F is true, because, we calculate with respect to u).	6 (19%)	4 (14%)	3 (11%)
3	Answers containing correct statement and some related explanations (e.g. if x=u then it is true).	1 (3%)	3 (11%)	2 (7%)
2	Answers containing correct statement but incorrect or no explanation (e.g. F is true).	4 (13%)	7 (25%)	4 (15%)
1	Totally wrong answers (e.g. False, because f(x) and f(2x+1) are different functions).	6 (19%)	8 (29%)	3 (11%)
0	"Do not know" or missed.	10 (31%)	6 (21%)	6 (22%)

APPENDIX G
EXAMPLES OF STUDENTS' RESPONSES AND FREQUENCIES FOR EACH JOURNAL WRITING

Journal Writing # 1

What did you learn about the integral concept in this lesson? Clarify your answer by using as many ways as you can (you can use verbal explanation, charts, examples, tables...).

Score	RESPONSE	EG1	EG2
5	Showing the main idea of the class with most of the important points	1 (4%)	0
4	Showing the main idea of the class with referring some important points or some appropriate exemplars	2 (7%)	0
3	Showing the main idea of the class so generally	8 (29%)	0
2	Showing some concrete statements reference to the main idea of the class.	17 (61%)	8 (38%)
1	Showing some concrete statements about math study, but not concrete enough	0	8 (38%)
0	Showing just feelings or learning impressions.	0	5 (24%)

Journal Writing # 3

If the following equality is given,

$$\int x^2 \cos(2x)dx = \frac{1}{2}x\cos(2x) + \frac{1}{4}(-1+2x^2)\sin(2x) + C$$

How can you check its correctness? Please check if it is true or false?

Score	RESPONSE	EG1	EG2
5	Correct answer or wrong answer due to trivial arithmetic errors (e.g. To check its correctness we take the derivative of $(\frac{1}{2}x\cos(2x) + \frac{1}{4}(-1+2x^2)\sin(2x) + C)$ and $\frac{d}{dx}(\frac{1}{2}x\cos(2x) + \frac{1}{4}(-1+2x^2)\sin(2x) + C) = x^2\cos(2x)$, so the equality holds.	0	2 (10%)
4	Correct explanation but no verification or verification but no explanation (e.g. We take the derivative of $(\frac{1}{2}x\cos(2x) + \frac{1}{4}(-1+2x^2)\sin(2x) + C)$.	1 (4%)	1 (5%)
3	(n/a)	0	0
2	Answers containing related important sub-ideas (e.g. Since the integral is the reverse of differential, first we consider it).	0	4 (20%)
1	Totally wrong answers (e.g. if we use the substitution $u = x^2$, we can prove its correctness).	25 (96%)	5 (25%)
0		0	8 (40%)

Journal Writing # 4

Evaluate the following integral, $\int \cos(x^2)d(x^2)$

Score	RESPONSE	EG1	EG2
5	Correct answer or wrong answer due to trivial arithmetic errors (e.g. If $u = x^2$ then $2xdx = du$ so $\int \cos(x^2)d(x^2) = \sin(x^2) + C$):	2 (7%)	7 (28%)
4	Correct logic but incorrect integration (e.g. $\int \cos(x^2)d(x^2) = -\sin(x^2)$).	14 (47%)	10 (40%)
3	(n/a)	0	0
2	Incorrect answer with some related approaches (e.g. $\int \cos(x^2)d(x^2) = \sin(x^2)d(x^2)$).	3 (10%)	2 (8%)
1	Totally wrong answers (e.g. $\int \cos(x^2)d(x^2) = \frac{\cos x^4}{4}$).	10 (33%)	3 (12%)
0	"Do not know" or missed.	1 (4%)	3 (12%)

Journal Writing # 5

Answer the following questions,

5(a) We can differentiate an integral by …….(Theorem).

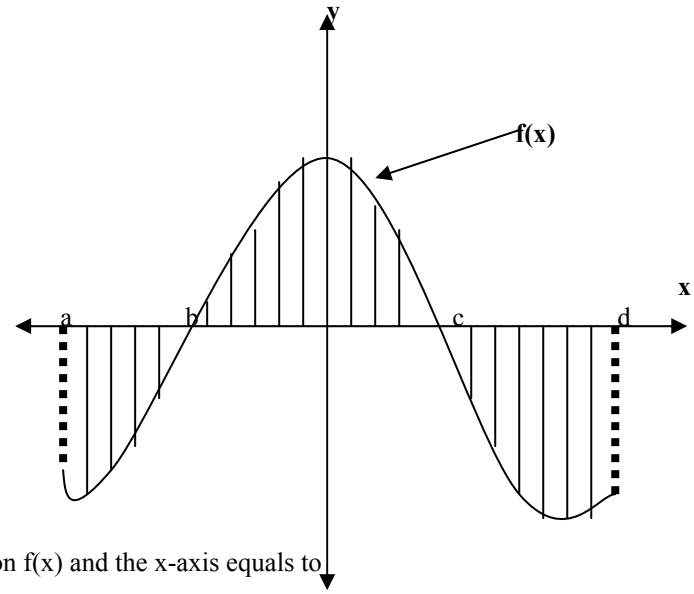
Score	RESPONSE	EG1	EG2
5	Correct answer (e.g. fundamental theorem)	14 (44%)	2 (8%)
4	(n/a)	0	0
3	(n/a)	0	0
2	Answers containing more than one answer, one of which is correct (e.g. mean value/fundamental)	1 (3%)	0
1	Totally wrong answers (e.g. substation theorem).	16 (50%)	10 (42%)
0	"Do not know" or missed.	1 (3%)	12 (50%)

5(b) Find the derivative of $\int_0^1 [x^3 2^x Cos(x+7)]dx$. Explain your answer as much as possible.

Score	RESPONSE	EG1	EG2
5	(n/a)	0	0
4	(n/a)	0	0
3	(n/a)	0	0
2	(n/a)	0	0
1	Totally wrong answers (e.g. $\frac{d}{dx}\int_0^1 x^3 2^x \cos(x+7)dx = 1.2.\cos(8) - 0$).	10 (31%)	7 (29%)
0	"Do not know" or missed.	22 (69%)	17 (71%)

Journal Writing # 6

Given the graph of the function f(x) as follows,



The area between the function f(x) and the x-axis equals to

a) $A = \int_a^d f(x)d(x)$

b) $A = \int_a^b f(x)d(x) - \int_b^c f(x)d(x) + \int_c^d f(x)d(x)$

c) $A = \int_a^b f(x)d(x) + \int_b^c f(x)d(x) - \int_c^d f(x)d(x)$

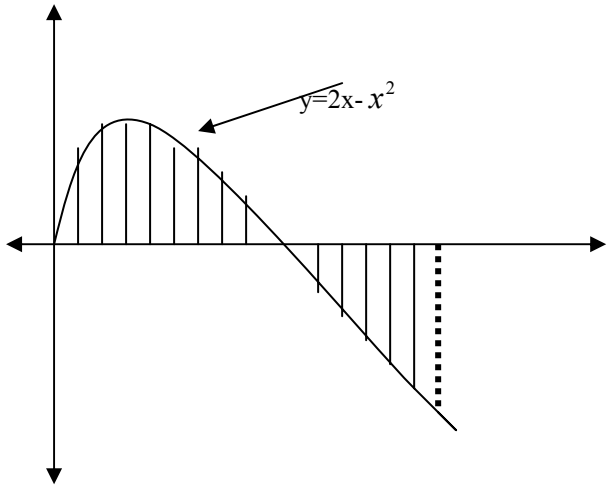
d) $A = -\int_a^b f(x)d(x) + \int_b^c f(x)d(x) - \int_c^d f(x)d(x)$

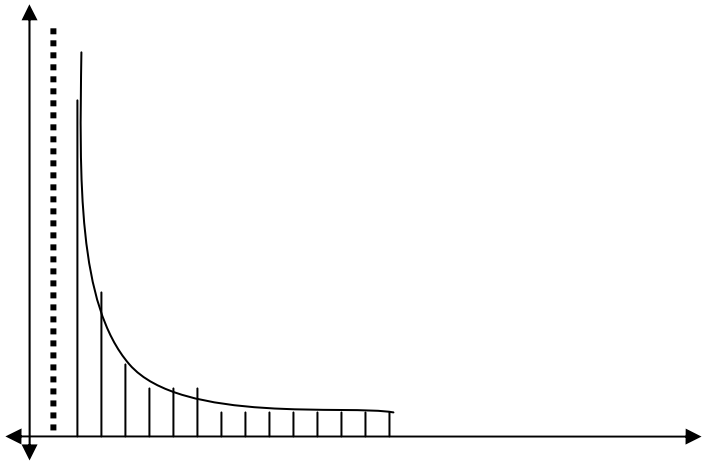
Explain your answer as much as possible.

Score	RESPONSE	EG1	EG2
5	(n/a)	0	0
4	Correct choice and explanations containing main ideas concerned with function and area under a curve (e.g. Area can never be zero because of that the area under x-axis should be multiplied by -1)	8 (30%)	1 (4%)
3	Correct choice and the explanations containing related sub-ideas concerned with function and area under a curve (e.g. Because a-b and c-d areas have minus value in y).	9 (33%)	7 (28%)
2	Correct choice but incorrect or no explanation (e.g. D is correct, because this formula is natural exponential function).	9 (33%)	15 (60%)
1	Incorrect choice and incorrect or no explanation (e.g. the answer is A, because the other choices have the negative integration of the functions and there is not any need for the negative of the integration. The function is already negative in (a,b) and (c,d)).	1 (4%)	1 (4%)
0	"Do not know" or missed.	0	1 (4%)

Journal Writing # 8

a) When the shaded regions below are rotated through 360° about x-axis, a solid is traced out.





If possible, write down the integral formulas for the volumes of the above solids. If it is not possible , explain why not?

a)

Score	RESPONSE	EG1	EG2
5	Correct answer (e.g. A, $\int_0^3 \pi(2x-x^2)^2\,dx$)	1 (4%)	0
4	(n/a)	0	0
3	(n/a)	0	0
2	Answers computing the area instead of volume or containing some related formulas of volume (e.g. $A=\int_0^2 (2x-x^2)dx-\int_2^3 (2x-x^2)dx$).	10 (35%)	12 (52%)
1	Totally wrong answers (e.g. $A=\int_0^2 (2x-x^2)dx$).	15 (52%)	3 (13%)
0	"Do not know" or missed.	3 (10%)	8 (35%)

b)

Score	RESPONSE	EG1	EG2
5	Totally correct answer (e.g. $V = \int_1^{\infty} \pi(\frac{1}{x})^2 dx$)	3 (10%)	0
4	(n/a)	0	0
3	(n/a)	0	0
2	The answers computing the area instead of volume or containing some related formulas of volume (e.g. $V = \int_1^{\infty} (\frac{1}{x})\ dx$).	6 (21%)	4 (17%)
1	Totally wrong answers (e.g. we can not compute the volume since x goes to infinity).	11 (38%)	11 (48%)
0	"Do not know" or missed.	9 (31%)	8 (35%)

Journal Writing # 10

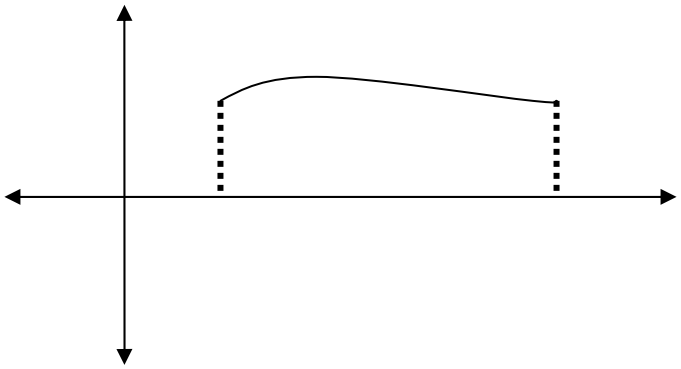
Write down (construct) an integral in which
a) Integration by parts **b)** Partial fraction **c)** Trigonometric substitutions method should be used to evaluate the integral. (**Do not evaluate the integrals)**

Score	RESPONSE	EG1	EG2
5	The answers in which all three responses are correct (e.g.	4 (14%)	0
4	(n/a)	0	0
3	The answers in which two of the options are correct (e.g.	7 (25%)	1 (4%)
2	The answers in which one of the options is correct (e.g.	8 (29%)	6 (26%)
1	Totally wrong answers (e.g.	9 (32%)	11 (48%)
0	"Do not know" or missed.	0	5 (22%)

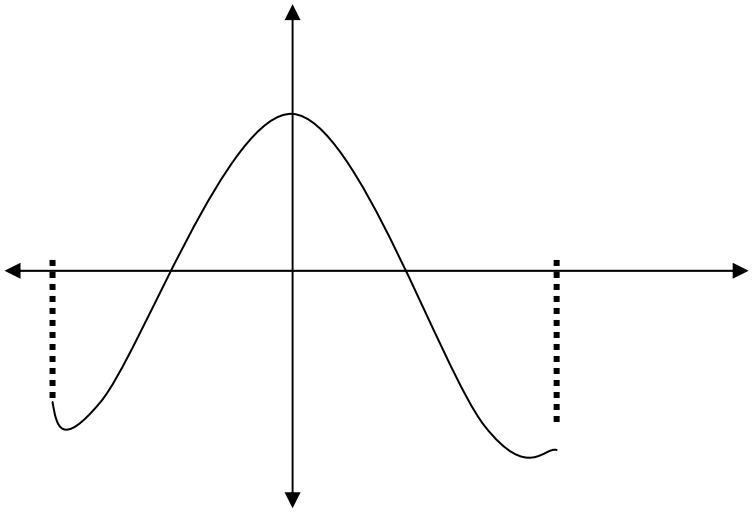
Journal Writing # 12

Here are two curves,

a)



b)



Can we evaluate the length of these two curves? If yes, write down the formulas for the lengths of the curves?

a)

Score	RESPONSE	EG1	EG2
5	Both part (a) and part (b) are correct without further questioning (e.g. $\int_a^b \sqrt{1+[f'(x)]^2}\,dx$ and **b)** $\int_c^d \sqrt{1+[g'(y)]^2}\,dy$).	1 (3%)	1 (4%)
4	One part is completely right and there is some progress in the other related to the answer (e.g. **a)** $\int_a^b \sqrt{1+[f'(x)]^2}\,dx$ **b)** $\int_c^d \sqrt{1+[g(y)]^2}\,dy$).	9 (29%)	1 (4%)
3	One part is totally right, the other part is totally wrong (e.g. **a)** $\int_a^b \sqrt{1+[f'(x)]^2}\,dx$ and **b)** $\int_c^d g(y)dy$	6 (19%)	1 (4%)
2	One of the parts has some related ideas, but the other part is completely wrong (e.g. **a)** $\int_a^b \sqrt{1+[f(x)]^2}\,dx$ **b)** $\int_c^d g(y)dy$	7 (23%)	13 (54%)
1	Both parts are totally wrong (e.g. **a)** $\int_a^b f(x)dx$ and **b)** $\int_c^d g(y)dy$).	8 (26%)	13 (54%)
0	"Do not know" or missed.	0	4 (15%)

Journal Writing # 14

If $\int_0^1 f(x)d(x) = 4$ and $f(x) \geq 0$, does $\int_0^1 \sqrt{f(x)}d(x) = \sqrt{4} = 2$?

Score	RESPONSE	EG1	EG2
5	Totally correct answer and correct explanation (e.g. It can not be equal because the square root inside the integration. Not out of the integration. If the square root would be over the integration, then it would be equal to 2).	1 (3%)	1 (4%)
4	Correct answer but incorrect counterexample (e.g. Wrong because if we take $f(x) = x^2$ then the equality does not hold).	3 (10%)	2 (7%)
3	Correct answer, correct counterexample but no verification (e.g. If we take f(x)=4x, then the equality does not hold).	0	3 (5%)
2	Correct answer but incorrect or no explanation (e.g. Wrong, because $\sqrt{f(x)} \neq \sqrt{f'(x)}$).	9 (31%)	8 (30%)
1	Totally wrong answers (e.g. Yes, it is true)	15 (52%)	9 (33%)
0	"Do not know" or missed.	1 (3%)	4 (15%)