SHS Web of Conferences **26**, 01066 (2016) DOI: 10.1051/shsconf/20162601066
*ERPA 2015*

# Reactions of the students to integral volume problems and socio–psycho–mathematical relationship

Özkan Ergene[1a], Ali Delice[2]

[1]Sakarya University, Faculty of Education, Hendek, 54300, Turkey
[2]Marmara University, Ataturk Faculty of Education, Istanbul, 34744, Turkey

**Abstract.** In this research; how the changes in reactions which university students give integral volume problems before solution and after solution affect the solution processes is inspected. In the study adopting qualitative paradigm's interpretive approach, case study is used as study design. Participants of the research are the 142 students which had been chosen from four different faculties of two universities in Istanbul, using non-probability sampling. Semi-structured interviews were conducted with two students randomly chosen from every department and Integral Volume Pre Solution Test and Integral Volume Solution and After Solution Test were used as data collection tools. The data have been analyzed using descriptive analysis and presented by frequency and percentage tables. As a result of the research, it is concluded that the reactions of the students in the faculty, their familiarity to the mathematical statement and their attitude towards the problem and faculty based institutional differences such as professors, professional expectation causes the evolution of the socio-psycho-mathematical relationship between university students and problems and that affects the solution processes.

## 1 Introduction

The concept of community of practices which have been started to be used in the healthcare, in the industrial area, in the educational field and in the online based business areas make progress in the recent thirty years [5, 21, 24, 27 and 29]. In the last quarter of the century, in the studies of educational field, the concept of communities of practices which is used as a theoretical framework was propounded [22] were grounded on mutual relationship dimensions including factors like learning tools and problem and the interaction of the individual as a student which are placed in the intermediary institution, targeted information and learning environment [6 and 7]. In the communities of practices, individuals can share their interest, problems and common anxieties and also they can

[a] Corresponding author: ozkanergene@sakarya.edu.tr

provided opportunities for specialization by working on a specific subjects or a field. The community of practices which participate for learning mathematic subjects are also used in mathematics education in some situations like individuals problem solving processes showing up in learning transitions [2 and 14], determining the differences between learning environments [11].

It could be considered that it could be useful to bring individuals in problem solving ability in the process of teaching the mathematics topics which are hard to learn, such as limits, derivatives and integrals, and characterized as hard [25]. Even though problem solving is described as a skill within the context of mathematics in the curriculum [23], mathematics educators explain it as a skill for both science and mathematics [19 and 20]. Problem solving could be affected by individual-oriented features such as skills, process, demographic variables, and environment-oriented features such as teacher, school or occasion [11]. Problem solving is considered as a structure that has knowns and unknowns. But it is important to notice that there are different methods between the knowns and unknowns, and that a process continues with different procedures mutually as circular. What is expected from the individuals is to interpret the knowns and unknowns, understand the problem in the light of the individual paradigms, and do mathematical operations by interpreting as a result of sense-making.

Considering that mathematics problems are only meaningful with their solution processes, the interaction between the problem and the person defines the direction of the solution process. These interactions and the intensity of the understanding process and complexity of the procedure can be influential factors on determining the direction of solving a problem, of which analysis course may be an example [18 and 20]. Analysis course, which can be considered a base for the topics such as limits, derivatives and integrals, is given in faculties of education, science, and engineering under the names of Analysis 1-2, General Mathematics 1-2, and Calculus 1-2 [11 and 31]. The concept of integral which fall into the Calculus course consists of definite and indefinite integral parts. The difficulty in understanding of the subject definite integral has been accepted universally and many researches indicate that the students have problem in calculus subjects [6, 7, 26, 28 and 30-33]. The subject of volume by integral which is one of the ways practicing definite integral, treats the calculation of the volume of the rotatory object which forms the region formed by the limitation of the curves in general in the books above. On the subject of integral volume problems it can be said that some factors such as difficulty or easiness of the problem in calculating the volume of the rotatory object [9], visual skills reflected on problem-solving process [4], having full knowledge of subject's sufficiency [1] and approaches to problem [7] gain importance. Because the examination of the causes which lie behind answers which individuals give to the problem during the problem solving process will provide opportunity for interpretation of the solving process in an effective way.

Analyzing the reactions which we describe as the indicator of the experiences undertaken by problem solvers before and after problem solving process will provide opportunity for getting more understanding of problem solving process socially and psychologically. In this regard, upon solving integral volume problems, by viewing how the first reactions of university students to the problem at the beginning of the solving and their reactions after the solving affect the problem solving process; it is aimed in this study to define the personal relation between university students and integral volume problems in the context of community of practice.

## 2 Methodology

This study which aims to research how integral volume problems' effects before/after the solution affects solving process in the context of study group is conducted with non-

positivist interpretive paradigm [15]. The need for natural observation of reactions and individual factors happened the solving process, which can be stated as an indicator of life experiences that have been had before/after the solution process, has had an influence in choosing the research paradigm. Due to response checks before/after the solution process and being seen this responses on the solving process as a special case, research design is identified as a case study.

When the suitability of the character of the qualitative paradigm and that integral volume problem solving processes are examined in the context of institutional difference in the determination of the reactions before and after solution are considered, the study group of the research consists of 142 student who are defined from four different faculty which forms faculty of education secondary and primary mathematics teaching departments, faculty of science and letters department of mathematics and engineering faculty environmental engineering, civil engineering and mechanical engineering of two different university of Istanbul province (Table 1). With the purpose of deepening the investigation of the solution processes in the context of the reaction to the integral volume problems semi-structured interviews with two students randomly chosen from each faculty have been carried out regardless of the success or skill because the solution process and the reactions given in this process are important.

Table 1.Study Group

| University | Faculty | Department | Code |
|---|---|---|---|
| A | Faculty of Education | Secondary Mathematics Teaching Department | SMT |
| B | Faculty of Education | Primary Mathematics Teaching Department | PMT |
| B | Faculty of Science and Letters | Department of Mathematics | MD |
| B | Engineering Faculty | Departments of Environmental Engineering, Civil Engineering, Mechanical Engineering | EF |

In the research, Integral Volume Pre-solution Test (IVPST) and Integral Volume Solution and After-Solution Test (IVAST) consisting of seven problems and created by researchers were used as data collection tool. During the process of research, university students were asked to choose among the options of easy -medium -hard placed under the questions, first before they solved the problems in IVPST and then after they solved the problems IVAST. Besides, semi-structured interviews with two students chosen from each faculty were carried out with the intent of detailed examination of the reactions that university students gave in their processes of solutions of integral volume problems.

The qualitative data, first of all, have been analyzed with the grouping method. During the process of analysis of data, the reactions to the IVPST and IVAST are presented with the percentage calculations being analyzed in the category of easy, medium and difficult. Then, IVAST solutions have been coded as correct answer (CA), wrong answer (WA), partial answer (PA) and no attempt (NA) and percentage calculations are presented. Finally, descriptive analysis have been carried out for semi-structured interviews which are had with the university students.

## 3 Findings

Firstly, in the manner that it include whole study group, as integrative, then to define whether that institution differences and individual differences to affect the solution process become in the reactions to the problem; the findings of the research are presented in the category of easy, medium and difficult while four faculties are given separately. Moreover, integral volume problems solution performances related to four faculties have been given.

Finally it will be presented findings related to semi structured researches done with university students.

The reactions to the IVPST and IVAST are inspected, (Table 2) it is observed that of the 9% university students change their reactions by giving difficult reaction to the after solution problems. It has been seemed that individuals cite 33.8% of the problems with IVPST as easy, 21.7% as difficult and the residual of 45.2% as medium. Also after IVAST was solved, it was observed that the number of students that found it easy or medium or difficult have decreased.

Table 2. Percentage Table Related to Reaction to the IVPST and IVAST

| | Easy | | Medium | | Difficult | |
|---|---|---|---|---|---|---|
| **Problem Number** | **BS (%)** | **AS (%)** | **BS (%)** | **AS (%)** | **BS (%)** | **AS (%)** |
| **1** | 72,5 | 72,5 | 26 | 21,2 | 1,4 | 6,2 |
| **2** | 51,2 | 33,7 | 43,9 | 52,7 | 4,8 | 13,5 |
| **3** | 34,7 | 14,3 | 54,5 | 46,6 | 10,7 | 39 |
| **4** | 18,5 | 24,7 | 50,7 | 39,4 | 30,7 | 38,4 |
| **5** | 20,8 | 17 | 55,8 | 41,1 | 30,6 | 41,1 |
| **6** | 20,8 | 19,7 | 47 | 47,8 | 32,1 | 25 |
| **7** | 18 | 22,5 | 39,2 | 31 | 42 | 49 |
| **Total** | 33,8 | 29,2 | 45,2 | 40 | 21,7 | 30,7 |

It is observed that the number of individuals who says easy to the first problem is most and also the number of individuals who declare that the problems after IVAST in all problems are difficult increases. It is seen that the number of individuals who describe that the difficulty of problems are medium is close to each other and high number.

It is observed that the reactions which students of the SMT Department gave to the IVPST and IVAST are similar to each other. Almost half of the students (48.4%) say that the problems in the IVPST are medium, 27.2% as easy and the rest 24.4% as difficult. It is seen that there are very small differences in the reaction to the IVAST. It is observed that the number of individuals, who claimed other problems than the second problem were easy, increased, the number of individuals, who claimed the third and fifth problems were average, decreased dramatically when the problems took place in test are reviewed.

When the reactions of PMT students to the IVPST are analyzed, almost half of the students described the problems in the test as medium, 24.8% as easy, 28.2% difficult. When the reactions to the IVAST are analyzed, it is observed that the number of the individuals who describe the problem as easy have increased and the number of individuals who says medium and difficult for the problem have decreased. In the problem based examinations, while none of the individual describe the fourth problem in the IVPST as easy, nearly a third of the students evaluate the problem as easy after IVAST. Moreover, it is observed that the number of individuals who say easy for all problems have increased except third problem in the direction of the reactions to the IVAST.

43.1% of MD students find the problems in IVPST easy, 38.2% describe them medium and 18.5% label them difficult. Nearly a third of individuals have decided that problems after IVAST are difficult. It is seen that the number of the individuals who describe the problems as easy of medium have decreased as a result of the reactions to the IVAST problems. Moreover, the numbers of individuals who describe the all problems in the test are more difficult after solution. The individual reactions to especially third problem in the test have greatly changed, while the ones who says easy hardly ever stay, the majority of individuals stated that the problem is difficult after solution.

It is seen that 40.1% of EF students stated that the problems in the IVPST are easy, 16.5% of them describes as difficult and almost half of them (47.7%) find them medium. After individuals solve the problems in the IVAST, a small section of them (5%) change from their easy expressions to difficult ones. The reactions which individuals gave problems as medium show similarity in every two tests. Besides, it is observed that the majority of the individuals found the first problem easy, the number of individuals who describe all problems in the IVPST as difficult except sixth problem have increased after IVAST.

When the performances related to IVAST are analyzed, it is seen that almost half of the university students (40%) can't give an answer. It is observed that the department giving the most WA to IVAST is SMT and the department giving the most NA is MD.

In the semi-structured interviews with university students, the following are met before and after problem.

• Being seen that perspectives of pre-solution and after-solution can change (this situation support the situation of reaction change taking place in the before and after solution test),

*...The problems seemed easy at first, but after trying out the solution I couldn't figure out the integrals, so we haven't covered some of the problems in class I have understand that the test is difficult…*

• Having met with the problem earlier in the solving process,

*....I have seen certain parts of some problems in the course, so I could do…*

• Seeing various mathematical sentences being learned in advance in the problem,

*....The easiest problem was first and second problem because parabola and line equations are the ones I always know…*

• Changing of the point of view on problem in the context of affiliated faculty,

*...When I handled first test, I thought that the tests are in medium difficulty. Indeed, my idea did not change after solution. The problems seemed to me neither much attractive nor much repellent. This test became a test in medium difficulty…*

*...First and second problems were not difficult, there was not an extreme difficult problem but third and fifth problem were a bit serious. While I was solving some problems, I came to a solution at no time, I wish the exams were in this way…*

• The interactions which individuals experience between the problem and themselves during the problem solving.

*...But some problems; for example seventh problem were difficult because I felt not to like while solving...*

Being assessment and evaluation factors such as mid-term and final exam…

*...Field exam turned up, I think what our reaction is not important, we should solve each problem….*

## 4 Discussion and Conclusion

Changing of the reactions substantially after solution which university students gave to integral volume problems before the solution, in problem-solving processes can be thought as an indicator of interaction of the university students with the problem in the solving process. In solving processes, factors like loving the problem, develop a positive point of view gain advantage. On the other hand, factors like not loving the problem, alienation from the problem in solving process or leave unsettled are a disadvantage in solving-process. In the test which university students mainly qualified as an average, the finding that the individuals who qualified the problems as an easy are more than the individuals who qualified as a hard, at first makes think individuals who will solve the problems are more. Because qualifying the problems as an easy or medium, can be considered as a

reason why provides the answers required in the beginning and after the solution. Because the difficult problems are defined as complicated problems which require more cognitive activity and information [9], it can be thought that a solving-process of the problems which university students qualify as hard is more complicated. And this may mean individuals qualify the test as easy must find correct answer easily. However, it has been observed that different variables such as procedural, formulaic, spatial and algebraic ability required in problem-solving process are emerged in the course of problem-solving and create awareness in problematic relations of students. This situation may show that students first of all should calculate on problem to identify it. The importance of problem-solving process and evaluation after solution should not be ignored. In this regard, it can be said that problems, solving processes and conclusions are meaningful all in all [6, 7 and 11].

In integral volume problems, the alteration of the students' reactions against problems with algebra or graph, we can say that it is affected by situations like solution options in problem-solving [16], the existence of equation and quadratic equation which are used excessively in teaching process (e.g first problem). This situation which can be seen as evidence to show its sources originated from the point of view against problem, changes the reactions of university students. Because equation and quadratic equation which are frequently used in teaching process, can trigger the reaction as an easy before test. This reaction can be differentiated by university students depending upon variance of necessary actions in solving process. In this regard, the importance of life experience relating to problem rise in importance in problem-solving process.

The alteration of reactions that university students gave to tests also show that the students in faculty approach cautiously at first. That the students in faculty of education increase reactions as easy after solution, can be thought as an indicator of analyzing the problem in solving process and reflect to necessary operations. On the other hand, that the students from faculty of science and letters and faculty of engineering increase reactions as hard can show that they did not analyze problem very well and did not reflect the necessary steps. Institutions which are secret or open in the process of performance ensemble's formation contribute to formation and affect teaching afterwards [34]. It has been seen that individuals gain different behaviour because of characteristic and structure of the institution and also because of the general aims which institutions should bring to individuals [11]. Because, the existence of different reaction alterations in different faculties can be thought as an indicator that information of the students solving the same problem are also different. If we think that corporate relations have cognitive affects and are important to become the alterations apparent [3], changing student reactions and performances in the context of institutions reveals that we should dispute cases such as faculties, learning in faculty, learning environment, lecturer.

To conclude, it has been seen that performance, mathematical ability, approach to problem and encountering volume integral's in midterm, final, department math exams are effective in changing the reactions of university students to volume integral problems. In problem interpretation process, approaches of the university students when they encounter the problem are important. This approaches originate from the factors as a personal characteristic like psychological adaptation [17], self-confidence [10] and also like a personal differences [11] or effectiveness of communication skills [8] and corporate differentiation [12 and 13] in problem-solving process. In this context, individual relationships of university students with volume integral problems can be evaluated in terms of social (the relation between problem solver and problem which is similar to individual), psychological (university student) and mathematical (epistemological) [6]. In problem solving process, from seeing the first time a problem to the end of the problem-solving and also socio-psycho-math relation which we may encounter after problem-solving can show the alteration and development of the university students' view. Directly

accepting the existence of socio-psycho-math relation enable to analyze problem-solving processes which are impossible to observe directly and especially enable to specify personal characteristics and differences. So, it has been thought that it can provide a different point of view during analyzing the problem-solving processes in mathematics education.

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