



# Software Engineering Exams of Bachelor Students - some Conclusions

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Opatija, Croatia, 3 September – 8 September 2012



## Contents

- Overview
- Three types of examination questions
- Fields of knowledge
- The influence of the preparation
- Conclusions

## Overview

### Written exam after winter semester 2011/2012:

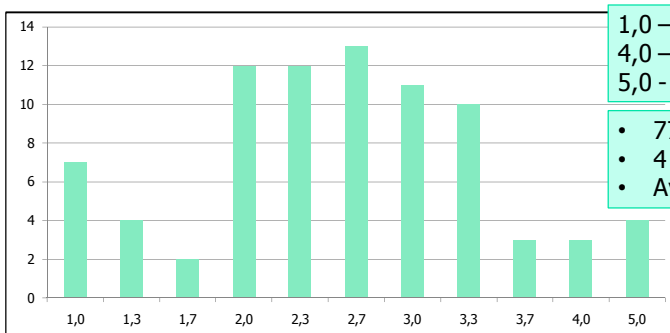
- Time: 120 minutes
- Number of tasks: 43 (with subtasks 64)
- Instruction: short answers in free spaces
- Maximal points: 180
- students:  
101 accepted for exam, 87 registered,  
81 participated

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3

## The main result

Mark	1,0	1,3	1,7	2,0	2,3	2,7	3,0	3,3	3,7	4,0
Points	153,0	144,0	135,0	126,0	117,0	108,0	99,0	90,0	81,0	72,0
%	85,0	80,0	75,0	70,0	65,0	60,0	55,0	50,0	45,0	40,0



1,0 – best grade: excellent  
4,0 – just passed  
5,0 - failed

- 77 students passed
- 4 students failed
- Average grade: 2,61

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4

# Our basis for the statistical evaluation



student no.	nb.	points	1		2		3		4		5		13			14			15			16			44			45			50			51			52			60			61			62			63			64			overall
			1	2	3	4	5	a	b	c	d	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c														
533591	1		1,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	1,0	2,0	1,0	2,0	3,0	3,0	0,0	4,0	3,0	2,0	2,0	2,0	1,0	151,0																															
539272	2		1,0	1,0	2,0	2,0	1,0	1,0	1,0	2,0	0,0	3,0	3,0	2,0	3,0	0,0	1,0	0,0	2,0	2,5	2,0	104,0																																	
543474	3		1,0	1,0	2,0	2,0	4,0	1,0	1,0	2,0	0,0	3,0	3,0	3,0	3,0	1,0	3,0	1,0	2,0	2,5	2,0	107,0																																	
537231	4		1,0	1,0	2,0	2,0	3,0	1,0	1,0	2,0	1,0	3,0	1,5	3,0	3,0	3,0	3,0	2,0	1,0	3,0	1,5	126,5																																	
539658	5		0,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	0,0	3,0	3,0	0,0	0,0	0,0	3,0	0,0	0,0	3,0	2,0	98,0																																	
539678	6		1,0	1,0	2,0	2,0	3,0	1,0	1,0	2,0	0,0	2,0	3,0	0,0	0,0	0,0	3,0	0,0	0,0	2,0	1,0	94,0																																	
539690	7		1,0	1,0	2,0	2,0	2,5	1,0	1,0	2,0	1,0	3,0	3,0	0,0	0,0	2,0	3,0	2,0	2,0	3,0	2,0	122,5																																	
535372	8		1,0	1,0	2,0	2,0	1,5	1,0	1,0	2,0	1,0	2,0	2,0	3,0	1,5	3,0	0,0	0,0	0,0	0,0	0,0	117,5																																	
539748	9		0,0	0,0	0,0	0,0	0,0	1,0	1,0	2,0	1,0	3,0	3,0	3,0	3,0	1,0	1,5	1,0	1,0	3,0	1,0	131,0																																	
540812	73		1,0	1,0	2,0	2,0	2,5	1,0	1,0	2,0	1,0	3,0	3,0	3,0	3,0	3,0	2,0	2,0	2,0	2,5	1,0	153,5																																	
540789	74		1,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	1,0	3,0	1,5	3,0	3,0	3,0	3,0	2,0	2,0	3,0	2,0	157,5																																	
540748	75		1,0	1,0	2,0	2,0	1,0	1,0	1,0	2,0	0,0	1,0	3,0	0,0	0,0	3,0	3,0	2,0	2,0	2,5	1,0	108,0																																	
540755	76		0,0	1,0	2,0	2,0	1,5	1,0	1,0	2,0	0,0	3,0	3,0	0,0	0,0	2,0	1,5	0,0	0,0	0,0	0,0	89,5																																	
537472	77		1,0	1,0	2,0	2,0	1,5	1,0	1,0	2,0	0,0	3,0	3,0	0,0	0,0	1,0	1,0	2,0	2,0	3,0	2,0	109,5																																	
540727	78		0,0	1,0	2,0	2,0	1,0	1,0	1,0	2,0	0,0	3,0	3,0	0,0	0,0	0,0	2,0	2,0	1,0	1,5	0,0	90,0																																	
533440	79		0,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	1,0	3,0	3,0	2,0	2,0	1,0	0,0	1,0	1,0	3,0	1,5	114,5																																	
532115	80		1,0	1,0	2,0	2,0	2,5	1,0	1,0	2,0	1,0	3,0	3,0	3,0	2,0	3,0	3,0	2,0	1,0	2,0	1,0	150,0																																	
529417	81		1,0	1,0	2,0	2,0	2,0	1,0	1,0	2,0	0,0	3,0	2,0	1,0	3,0	0,0	3,0	2,0	2,0	2,0	1,0	117,0																																	
min			0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	38,0																																	
max			1,0	1,0	2,0	2,0	4,0	1,0	1,0	2,0	1,0	3,0	3,0	3,0	4,0	3,0	2,0	2,0	3,0	2,0	162,0																																		
average %			66,7	96,3	96,3	96,9	56,6	93,8	93,8	95,1	46,9	85,0	78,6	42,4	38,7	58,4	74,9	58,0	71,3	74,1	54,3	63,1																																	

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5

# Contents



- Overview
- Three types of examination questions
- Fields of knowledge
- The influence of the preparation
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6



## Types of examination questions

- Knowledge question: 31 tasks (45 subtasks)
- Apply skills: 7 tasks (14 subtasks)
- Multiple choice: 5 tasks

student no.	Punkte	Multiple Choice					skills					knowledge															overall
		10	11	17	23	42	19	24	25	28	38	overall	1	5	6	32	33	40	41	43							
533591	3.0	1.5	1.0	3.0	2.0	12.5	9.0	5.0	6.0	4.0	7.0	2.0	3.0	50.0	1.0	2.0	2.0	3.0	3.0	0.0	4.0	2.0	2.0	1.0	88.5		
539272	2.0	1.5	1.0	2.5	2.5	9.5	9.0	5.0	1.0	2.0	7.0	0.0	0.0	44.0	1.0	1.0	2.0	3.0	2.0	3.0	0.0	0.0	2.0	2.0	50.5		
543474	2.0	0.5	0.0	1.5	2.5	6.5	5.0	2.0	0.0	2.0	7.0	2.0	3.0	42.0	1.0	4.0	0.0	3.0	3.0	3.0	1.0	1.0	2.0	2.0	58.5		
537231	3.0	1.0	2.0	4.5	3.0	13.5	0.0	4.0	3.0	6.0	7.0	1.0	2.0	33.5	1.0	3.0	2.0	3.0	3.0	3.0	3.0	2.0	1.0	1.5	79.5		
539658	1.5	1.5	0.5	3.5	3.0	10.0	6.0	4.0	0.0	0.0	7.0	2.0	3.0	34.0	0.0	2.0	2.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0		
539678	3.0	1.5	0.5	2.0	2.0	9.0	6.0	3.0	1.0	2.0	7.0	1.0	1.0	34.0	1.0	3.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	1.0	51.0		
538990	3.0	1.5	1.5	1.0	3.0	10.0	9.0	3.0	0.0	1.0	7.0	2.0	2.0	48.0	1.0	2.5	2.0	0.0	0.0	0.0	2.0	2.0	2.0	2.0	64.5		
535372	2.0	0.5	1.0	4.5	0.0	8.0	10.0	2.0	0.0	0.0	7.0	2.0	1.0	43.0	1.0	1.5	2.0	3.0	3.0	1.5	3.0	0.0	0.0	0.0	66.5		
539748	1.5	1.5	0.5	4.5	3.0	11.0	8.0	5.0	5.0	4.0	7.0	2.0	3.0	59.0	0.0	0.0	0.0	3.0	3.0	3.0	1.0	1.0	1.0	1.0	61.0		
538306	3.0	2.0	1.5	4.0	3.0	13.5	10.0	4.0	6.0	6.0	7.0	2.0	3.0	56.0	1.0	2.5	2.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	92.5		
532445	3.0	1.0	0.5	3.5	2.5	10.5	10.0	3.0	1.0	2.0	6.0	1.5	1.0	36.0	1.0	2.5	2.0	1.0	2.0	3.0	2.0	2.0	2.0	2.0	69.0		
536911	2.0	1.5	1.0	4.5	2.5	11.5	10.0	3.0	2.0	2.0	7.0	3.0	1.0	47.0	0.0	0.0	2.0	3.0	3.0	2.0	1.5	0.0	2.0	1.0	60.0		
539785	2.5	1.5	1.5	4.0	3.0	12.5	3.0	5.0	1.0	0.0	5.0	3.0	1.0	42.0	1.0	2.5	2.0	1.0	0.0	0.0	2.0	2.0	1.0	1.0	72.5		
538157	1.5	1.5	0.0	3.5	2.0	8.5	0.0	1.0	0.0	2.0	7.0	0.0	0.0	23.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	22.0		
533572	2.5	0.5	1.5	3.5	1.5	9.5	8.0	4.0	1.0	2.0	7.0	2.0	0.0	37.0	0.0	1.5	0.0	3.0	2.0	0.0	2.0	0.0	0.0	0.0	36.5		

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7



## Examples type 1: Knowledge question

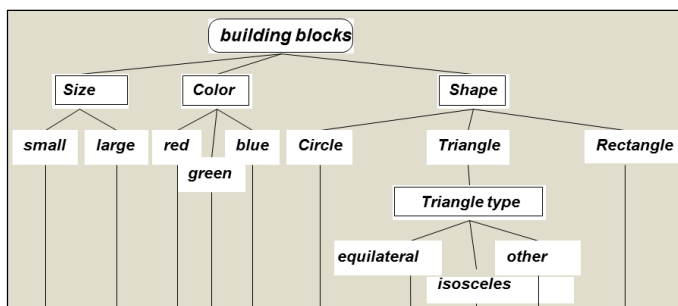
2. (1 point) Define internal and external software quality criterion?
3. (2 points) Classify as internal or external software quality criterion: maintainability, reliability, portability, scalability, testability, reusability, robustness.
20. (2 points) What is the importance of regression testing?
34. (3 points) What are the similarities and the differences of analysis patterns and design patterns ?
35. (3 points) What are the similarities and the differences of architectural patterns and design patterns ?

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8

## Example type 2: Apply skills

24. (5 points) Given: Classification tree for image identification.  
What is the minimal and the maximal number of test cases in that example?  
How can you find these numbers for arbitrary classification trees?



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9

## Example type 2: Apply skills

38. (9 points = 3 + 6) Calculate the cohesion measured with LOCM (Lack Of Cohesion of Methodes) for the following class.  
a) Give a definition for LOCM.  
b) Calculate the value LOCM. Discuss your result.

```

class Stack {
    private char[] stackElements;
    private int top;

    public Stack(int n) {
        stackElements = new char[n];
        top = -1;
    }

    public void push(char x) {
        top++;
        stackElements[top] = x;
    }

    public char toppop() {
        return stackElements[top--];
    }

    public int length() {
        return top + 1;
    }

    public int next (int n) {
        return n + 1;
    }
}
  
```

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10



## Example type 3: Multiple choice

10. (3 points) On which basis cost estimation for software projects is possible?

- a) Preliminary requirements specification  yes  no
- b) Requirements specification  yes  no
- c) Use Case Diagrams  yes  no
- d) previous projects  yes  no
- e) Division of a system to sub-systems  yes  no
- f) Information of the portion of a special phase as part of the whole system development  yes  no

**Assessment: 0.5 points for each correct answer**



## Comparison kinds of tasks

critierion	knowledge	multiple choice	Skills
quantity (subtasks)	45	5	14
possible points	97	15	68
average points %	<b>62,4</b>	<b>69,3</b>	<b>62,8</b>
min	11	5,5	17
max	92,5	14	63

## Kinds of tasks: Comparison between good and bad student-groups



students	average points %			
	overall	knowledge	multiple choice	Skills
all	63,1	62,4	69,3	62,8
10 best	85,8	86,5	82,3	84,2
10 worst	39,2	<b>36,5</b>	<b>57,0</b>	<b>39,0</b>

- best students: the distribution is balanced
- worst student: multiple choice leads to better result

Opatija, Croatia, 3 September – 8 September 2012

13

## Contents



- Overview
- Three types of examination questions
- Fields of knowledge
- The influence of the preparation
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Opatija, Croatia, 3 September – 8 September 2012

14

## Fields of knowledge: 5 types

- Basics: 6 tasks
- Analysis and Definition: 13 tasks (19 subtasks)
- Test: 11 tasks (22 subtasks)
- Design: 6 tasks (9 subtasks)
- Further problems: 7 tasks (8 subtasks)

1	C	Basics						Analysis and Definition											Test						Design										
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
2	task No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
3	overall																																		
4	points	1	1	2	2	3	2	11,0	2	3	3	3	2	2	1	1	2	10	43,0	2	2	2	3	3	3	3	3	3	3	3	71,0				
5	student no.	533591	1,0	1,0	2,0	2,0	2,0	10,0	2,0	3,0	1,0	3,0	1,5	2,0	1,0	1,0	2,0	9,0	36,5	2,0	2,0	2,0	2,0	3,0	3,0	3,0	3,0	3,0	3,0	3,0	67,5				
6	points	539272	1,0	1,0	2,0	2,0	1,0	2,0	9,0	1,5	2,0	1,0	2,0	1,5	0,0	1,0	1,0	2,0	9,0	27,0	0,0	1,5	0,5	3,0	3,0	0,0	3,0	0,0	3,0	41,5	0,0	3,0	2,0	3,0	0,0
7	points	543074	1,0	1,0	2,0	2,0	4,0	0,0	10,0	2,0	3,0	0,0	2,0	0,5	0,0	1,0	1,0	2,0	5,0	20,0	2,0	1,0	0,0	3,0	3,0	0,0	3,0	3,0	3,0	34,5	0,0	3,0	3,0	3,0	1,0
8	points	537231	1,0	1,0	2,0	2,0	3,0	2,0	11,0	2,0	2,0	3,0	3,0	1,0	2,0	1,0	1,0	2,0	0,0	28,0	1,0	2,0	1,0	3,0	1,5	0,0	3,0	3,0	3,0	56,0	4,0	3,0	3,0	3,0	3,0
9	points	539658	0,0	1,0	2,0	2,0	2,0	2,0	9,0	2,0	0,0	3,0	1,5	1,5	0,0	1,0	1,0	2,0	6,0	24,0	1,0	1,0	1,0	3,0	3,0	0,0	3,0	0,0	3,0	48,0	4,0	3,0	0,0	0,0	0,0
10	points	539678	1,0	1,0	2,0	2,0	3,0	2,0	11,0	1,5	3,0	3,0	3,0	1,5	2,0	1,0	1,0	2,0	6,0	30,5	2,0	1,0	1,0	2,0	3,0	0,0	3,0	0,0	3,0	36,5	1,0	1,0	0,0	0,0	0,0
11	points	539690	1,0	1,0	2,0	2,0	2,5	2,0	10,5	2,0	3,0	1,0	3,0	1,5	2,0	1,0	1,0	2,0	9,0	35,0	2,0	1,0	0,5	3,0	3,0	3,0	3,0	3,0	3,0	44,0	0,0	0,0	0,0	0,0	2,0
12	points	535772	1,0	1,0	2,0	2,0	1,5	2,0	9,5	2,0	3,0	1,0	2,0	0,5	2,0	1,0	1,0	2,0	10,0	34,5	3,0	1,5	1,0	2,0	2,0	3,0	3,0	3,0	3,0	48,0	2,0	3,0	3,0	1,5	3,0
13	points	539748	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	1,0	3,0	1,5	1,5	2,0	1,0	1,0	2,0	8,0	33,5	1,5	0,5	1,0	3,0	3,0	3,0	3,0	3,0	3,0	59,0	2,0	3,0	3,0	3,0	1,0

Opatija, Croatia, 3 September – 8 September 2012

15

## Comparison: Fields of knowledge

critierion	Basics	Analysis and Definition	Test	Design	further problems
quantity (subtasks)	6	19	22	9	8
possible points	11	43	71	32	23
average points %	<b>78,6</b>	<b>69,6</b>	<b>65,5</b>	<b>50,5</b>	<b>53,6</b>
min	0	10	12,5	1	0
max	11	40,5	67,5	32	23

Opatija, Croatia, 3 September – 8 September 2012

16



## Fields of knowledge: Comparison between good and bad student groups



students	average points %					
	overall	Basics	Analysis and Definition	Test	Design	further problems
all	63,1	78,6	69,6	65,5	50,5	53,6
10 best	85,1	90,5	87,8	86,3	83,1	76,1
10 worst	39,2	65,9	48,6	<b>41,2</b>	<b>19,5</b>	<b>29,8</b>

- bad group: we see a stronger decrease of the average points in the last chapters (design, further ...)
- better group: the distribution is more balanced

Opatija, Croatia, 3 September – 8 September 2012

17

## Contents



- Overview
- Three types of examination questions
- Fields of knowledge
- The influence of the preparation
- Conclusions

Opatija, Croatia, 3 September – 8 September 2012

18



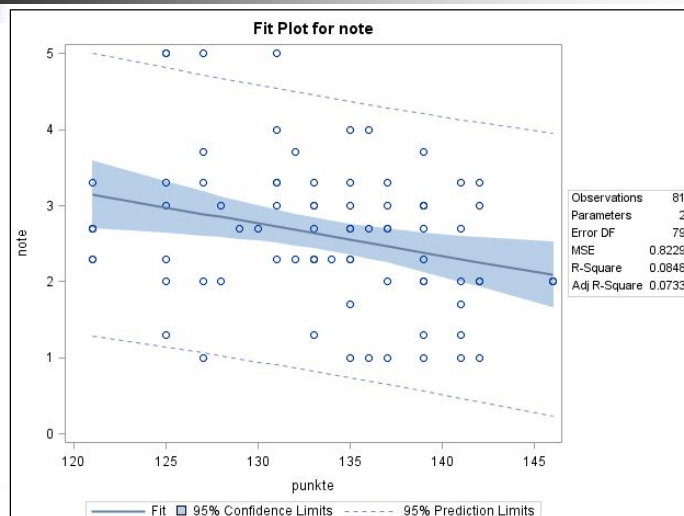
## The preparation for the exam

- to get the permission for the written exam the students have to solve 8 exercises and 6 practical assignments
- students work in groups of 3 persons
- they need 120 points (70 % of the possible points)

To find out if there is a correlation between the obtained preparation points and the result of the written exam we use the statistical program SAS (Statistical Analysis Systems)



## Significant correlation between the preparation points of the group and the exam result





## Conclusions

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- The written exam was successful, all tasks were solved, we get a normal distribution of the marks
- The time (120 minutes) was adequate
- The exam covered tasks from all chapters
- For **better students**, the type of task and the field of knowledge is insignificant
- The **worse students** achieved significant better results with multiple choice tasks, they were badly prepared to the last chapters of the course



## Conclusions

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- Groups of students with more points in the tutorials and practice tasks achieve better results in the exam

**Thank you for your attention!**