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ORGANISATION AND IMPROVEMENT OF TEACHING PRACTICE IN INFORMATICS

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This paper asks the question of how to organise teaching practices in Informatics and how to obtain the optimum results with restricted resources in order to provide our students with the appropriate level of computer literacy that is crucial for success in today's business world. Particular attention is paid to the problems of organising teaching practices with restricted resources and the organisation of a continuous improvement in teaching in such an environment. The organisation of a first year course in Informatics at the Faculty of Economics, Zagreb, has been presented. It has been demonstrated that a continuous improvement approach can be successfully applied in a university environment, and that it could be useful when organising teaching practices in Informatics.

Keywords: information technology education, course development, continuous improvement of education.

1. INTRODUCTION

The quality of education determines the long-term opportunities for prosperity for a nation and its people. There is no doubt that computer literacy is a must for all levels of education and especially a university education. If we want our students to become educated men and women, and allow them to communicate more effectively we have to teach them how to use computers successfully so they can solve any problems within their professions. At the University of Zagreb the main channel for providing students with computer literacy is a first year course in Informatics.

Learning Informatics is more complex than merely remembering what students have read or been told. Like most of the university courses in Croatia, the teaching of Informatics is conducted with *ex-cathedra* lectures and teaching practices. The informatics course is usually organised with the following two goals in mind: (1) to provide students with a fundamental knowledge of the capabilities of information technology (IT), and (2) to provide students with a basic level of competency to enable them to use applications software. The first goal is usually achieved with lectures and the second goal is achieved by various teaching practices in the computer labs.

In this paper we shall focus on the organisation and the improvement of the teaching practices. Although there is no doubt about the importance of computer literacy, our university lacks the resources for instructional technology investment,

which is a problem for many educational institutions [6]. A number of faculties have recently invested a lot of money in instructional technology, but still in most faculties in Croatia there are too many students working on a small number of computers with not enough teaching assistants to help them. Also, there is no question that quality of teaching should be constantly improved if we want our students to acquire a high level of computer literacy.

The main goal of this paper is to ask the question of how to organise teaching practices in Informatics and how to obtain the optimal results with restricted resources, and to recognise the best way for a continual improvement in teaching. Section 2 discusses the situation of the first year Informatics course at the Faculty of Economics, Zagreb. Section 3 discusses the system we use to measure the attainment of these teaching goals, and the system we use to obtaining student feedback. Section 4 deals with the system we use for quality improvement, and Section 5 discusses the approach taken to ensure Informatics is taught well despite all of the obstacles.

The results of a "Survey of students' attitudes to teaching practices in Informatics" [10] conducted in the academic year 1997/98 on a sample of 636 Informatics students will be presented. The survey was carried out in May 1998 when all subjects were covered, but before exams, and it was conducted by teaching assistants during the class. The objectives of the survey were to assess: (1) previous students' knowledge in using IT, (2) the attitude of students towards the usefulness of teaching practices, (3) increase in their knowledge of using IT, (4) what the students like and dislike, (5) what would the students add to these types of teaching practices. The results of the survey on students' previous knowledge of using IT will be described in Section 2. The attitude of students towards how useful the teaching practice is and the increase in their knowledge of IT and how they use it will be presented in Section 3. What the students like and dislike and what would students add to these methods of teaching practices will be outlined in Section 4.

2. THE ORGANISATION AND GOALS OF THE FIRST YEAR INFORMATICS AT THE FACULTY OF ECONOMICS, ZAGREB

The first year course in Informatics currently involves approximately 2,000 students and they are taught in 20 sections. Every week each section has two-hour lectures, and two-hour teaching practices. The main reason for the separation of lectures and teaching practice is the large body of students. Generally a lecturer teaches a section for a whole year, although sometimes this cannot be done because of various unforeseen circumstances.

Lectures are conducted in the conventional way using presentation and instructional technology like portable computers and LCD panels when appropriate. The main aim of these lectures is to provide students with a fundamental knowledge of the capabilities of information technology. At these lectures students learn about the general characteristics of computers, what the computers are good at, and what their limits are. They also learn some of the general properties of application software and the basics of programming.

On the other hand, with teaching practice, students learn "by example". Every class is organised around using specific application software and the Internet to solve a specific business problem. Teaching practices are conducted in computer labs. The main aim of the teaching practices are (1) to provide students with a basic level of competency, using applications software, and (2) to teach students how to use computers to successfully solve business problems.

The specific goal of these teaching practices is to teach students what kind of computer tools are appropriate for solving specific business problems. To be more exact, our goals are to teach students: (1) how to use word processors to create and maintain documents, (2) how to use spreadsheets to analyse data, how to create graphs and charts, how to convey numerical information in an easy-to-read format, and how to investigate relationships among data, (3) how to use the Internet for fast business communication by e-mail, and (4) how to find useful data by using search engines.

When we defined the goals for our course we asked ourselves: "Whom are we doing this for?" We can answer this question if we ask ourselves, "What interests do we have to satisfy in order to prosper?" For us to prosper we must talk about the need to improve our discipline and the contribution this makes to society, with it contributing to the well-being of our students and the institution that we work for, and also we hope this will lead to us having fun in the process. The answers to these questions lead us to the definition of "customers" and "product" for the first year course in Informatics [3].

The "customers" for our first year Informatics course are many and varied: the students, the lecturers of subsequent courses for which our course is a requirement, the future employers of our students, the discipline of Informatics, and the society as a whole. Our "product" for the students is to provide education and a qualification for them. All other customers benefit because of these educated and competent students. Therefore, our most important "customers" are students.

Teaching practices are conducted in computer labs. We have three computer labs that are equipped with: (1) 20 computers with 486 processors and colour monitors, (2) 10 computers with Pentium processors and colour monitors and (3) 12 multimedia computers with Pentium processors and colour monitors. There are approximately 100 students per section, with 70 of the students from each section coming regularly. We have decided to conduct our teaching practices almost entirely in computer labs, despite the fact that we have too few computers for too many students. The only type of lab that is acceptable for our course is one with 20 computers. Also, we have to divide students into two groups with about 35 students in each group. It is obvious that students have to work in pairs. Research assistants from the Department of Business Informatics hold teaching practice lessons with the assistance of senior students who prepare the classroom and help students when they have problems in solving the exercises.

For every course, and especially for the Informatics course, it is important to take into account what a student knew before joining the course. The students' level of

competency in using information technology (IT) is presented in Table 1. We asked students "How would you assess your level of competency in using information technology before you had any teaching practice in Informatics?" Because of time and money constraints it was impossible to investigate students' previous knowledge by ourselves, although we are aware that some students tend to overestimate their level of competency. Still only 5% of the students were "excellent", and only 16% were "very good" in using information technology before they had any teaching practice. This means that only every fifth student had a good formal education in IT at secondary school and/or some informal education by using their computers in their homes. About 25% of the students had a "good" level of knowledge previously. More than 50% of the students had "some" or "no" previous knowledge of using IT.

Table 1. The students' level of competency in using information technology before any teaching practices in Informatics

Level of competency	Number of students	%
Excellent	33	5,19
Very good	101	15,88
Good	163	25,63
Some	197	30,97
None	133	20,91
No response	9	1,42
Total	636	100,00

Our specific goals for teaching practices are strongly connected to software applications. Therefore, we wanted to assess students' previous knowledge of using an operating system like Windows 3.11 or Windows 95, of using a word processor, of using a spreadsheet, and of using the Internet. Again, we asked students, "How would you assess your level of competency in using: (1) an operating system, (2) a word processor, (3) a spreadsheet and (4) the Internet before teaching practice in Informatics?" Students were on average more skilled in using Windows and a word processor, but had less experience in using spreadsheets or the Internet. We would like to stress that more than 50% had no knowledge of using the Internet before this teaching practice.

Table 2. The students' knowledge of a software application/ an operating system before any teaching practices in Informatics

Knowledge	Operating system	Word processor	Spreadsheet	Internet
Excellent	96	84	56	59
Very good	140	142	117	63
Good	143	145	131	85
Some	163	158	141	120
None	94	107	191	305
No response	-	-	-	4
Total	636	636	636	636

Finally, we wish to emphasise that we take into account some general principles of learning when we try to accomplish our goals for these teaching practices in Informatics:

- **Students learn by constructing knowledge.** Although a teacher or a book presents knowledge in a clear way, students will understand material only after they have constructed their own understanding of what they are learning [11]. At every teaching practice students are given exercises that they have to work out by themselves. Exercises are designed to illustrate business applications of IT.
- **Students learn by active involvement in learning activities.** Students learn more if they work co-operatively in small groups to solve problems [7]. Students work in pairs and are assisted by senior students. We allow them to communicate with each other and help each other as much as they want, and this creates a friendly and relaxed atmosphere.
- **Students learn something well only if they keep practising it and doing it.** Repeating and reviewing tasks will not improve students' skill or improve their deeper understanding [5]. Students learn better if they continually apply ideas in new situations.
- **Teachers should not underestimate the difficulty students have in acquiring basic computer literacy.** There is a certain number of students that have anxiety attacks and resistance to technology because of their low level of knowledge and experience [4,9].
- **Teachers often overestimate students' level of competency in using information technology.** From our experience we have learned that there are a number of students that tend to exaggerate about their level of competence in using information technology.
- **Students learn better if they receive consistent and helpful feedback on their performance.** Feedback on how well they are doing is important for students, but it should be analytical, and it should come at a time when the students are interested in it [1]. At every teaching practice we check how students have solved the exercise. Also, students compare their work with each other.
- **Students learn to value those things that they know will be assessed.** Students try to acquire only those skills and activities which they know they will be evaluated on [12]. On one occasion we told students that they would not be tested on a specific topic. We realised that their effort was minimal, so we decided to evaluate them anyway. When students were notified about our decision, they immediately started to work very hard.

3. MEASURING THE ATTAINMENT OF EDUCATIONAL GOALS

The main purpose of teaching is to allow students to gain knowledge that has been defined in terms of educational goals. There are two ways of measuring the attainment of educational goals: (1) the assessment of students in terms of measuring how well a

student has learned a unit from the course and (2) an assessment of the teaching process in terms of measuring how well it has prepared a student to learn a unit from the course.

We assess students at the end of the winter and at the end of the summer semesters. To be more precise, we assess their level of competency in using applications software. During the school year, in every class, students receive a different exercise and they try to solve it. We do not formally assess how successful they are, but we spot students that are having difficulties and we help them. At the end of each semester every student receives a final exercise which is concerned with how to use a specific piece of application software or the Internet in a business situation. If the student solves the exercise successfully, he or she passes the test in teaching practices, and is allowed to go to the final exam in Informatics.

The assessment of the teaching process is concerned with gathering student opinion. We have decided to conduct "A survey of students' attitudes to teaching practice in Informatics". In order to measure our past performance we tried to capture the attitude of the students towards the usefulness of teaching practices and if there was an increase in their knowledge about how to use IT.

We asked students two questions: (1) "Do you think that teaching practice in Informatics was useful?" and (2) "How satisfied were you with the teaching practices in Informatics?". Almost every student (98%) thought that teaching practice in Informatics was useful. The results of the second question are presented in Table 3. Every fifth student (22%) was very satisfied, and more than half (58%) was satisfied with this teaching practice. 18 % of the students were neither satisfied nor dissatisfied. Finally, only 2% was dissatisfied and less than 1% was very dissatisfied. The results are satisfying especially if you take into account the difficult conditions (the small number of obsolete computers, too many students, and too few teaching assistants).

Table 3. Students' satisfaction with the teaching practices in Informatics

Satisfaction degree	Number of students	%
Very satisfied	135	21,23
Satisfied	365	57,39
Neither satisfied nor dissatisfied	114	17,92
Dissatisfied	12	1,89
Very dissatisfied	2	0,31
No response	8	1,26
Total	636	100,00

It was particularly interesting to find out if there was connection between students' previous knowledge and their satisfaction with the teaching practices. The results are presented in Table 4. We could conclude that satisfaction with teaching practice in Informatics is positively correlated with previous knowledge. For example, 42% of the students with excellent knowledge were very satisfied. On the other hand, only 18% of

students with no previous knowledge were very satisfied. We have to emphasise that the survey was done before their exams, so students' satisfaction could not be connected with their performance in the exam.

Table 4. Students' satisfaction with the teaching practices in Informatics according to previous knowledge (%)

Previous knowledge	Students' satisfaction with the teaching practices in Informatics					
	Very satisfied	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied	Very dissatisfied	Total
Excellent	42%	27%	24%	6%	0%	100%
Very good	25%	55%	19%	1%	0%	100%
Good	20%	60%	16%	4%	0%	100%
Some	19%	62%	17%	0%	1%	100%
None	18%	59%	20%	2%	0%	100%

We also wanted to determine students' perception of just how much they have learned. Therefore, we asked them to estimate, as a percentage, how much their knowledge had increased after this teaching practice. From the results presented in Table 5 we can conclude that students think that their knowledge has increased the most in the areas concerned with using spreadsheets and the Internet. This was expected, especially if you take into account the fact that students were weak in these subjects before joining the course.

Table 5. The increase in knowledge after the teaching practices according to previous knowledge

Increase in knowledge	Windows	Word	Excel	Internet
75% - 100%	76	75	101	141
50% - 75%	207	213	229	189
25% - 50%	178	185	191	156
0 - 25%	166	157	111	142
No response	9	6	4	8
Total	636	636	636	636

This increase in knowledge does not mean a lot if we do not take into account students' knowledge before starting the course. In Table 2 we have presented the students' knowledge of software application/operating systems before any teaching practice in Informatics. We used this information to assess the increase in knowledge according to their previous knowledge for every application. We have presented the results only for word-processing in Table 6. It is obvious that most students with excellent and very good knowledge estimated the smallest increase in their knowledge after teaching practice. Most of the students with good, some or no knowledge estimate

that their knowledge has increased by 50% to 75%. These results are similar for the operating system, spreadsheets and the Internet.

Table 6. The increase in knowledge of word processing after the teaching practices according to previous knowledge

Knowledge before teaching practice	Increase of knowledge in word processing after teaching practice			
	75% - 100%	50% - 75%	25% - 50%	0 - 25%
Excellent	9	11	6	56
Very good	23	29	41	47
Good	16	59	59	11
Some	13	74	56	14
None	14	40	23	29
Total	75	213	185	157

4. THE CONTINUOUS IMPROVEMENT OF THE SYSTEM OF TEACHING

Educational institutions have recently started to implement Continuous Quality Improvement, which is a management philosophy that is better known as Total Quality Management [8,2]. One should realize that a continuous improvement system of teaching concerns an important set of feedback loops that are depicted in Figure 1. The first feedback loop is concerned with student attitudes and their performance and that it is determined by their teachers' actions. It is important to realize that it takes a lot of time to change student attitudes and their performance. At the Faculty of Economics we use a survey to measure student attitudes on a year-to-year basis, and we measure these students' performance with an exam at the end of the semester. We use these measures to compare student attitudes and their performance with the teaching goal that we established at the beginning of the school year. If there is a gap between our teaching goal and the student attitudes and their performance, we (the teachers) change our methods in order to achieve our teaching goal. The second feedback loop determines our teaching goal. Students give suggestions about the teaching practices and about what they like and dislike, and what they would change. Teachers take some of these suggestions into account and change the teaching goal, but this can take some time. A new teaching goal influences teachers' actions, which in turn influence students' attitudes and their performance.

At the Faculty of Economics "A survey of students' attitudes to teaching practices in Informatics" was used as a basis for improvement. We asked students what they liked about teaching practice in Informatics in order to assess the advantages of the current organisation system. The results are presented in Table 7. The students liked the Internet, the help from senior students and teaching assistants and the opportunity to work with computers the most.

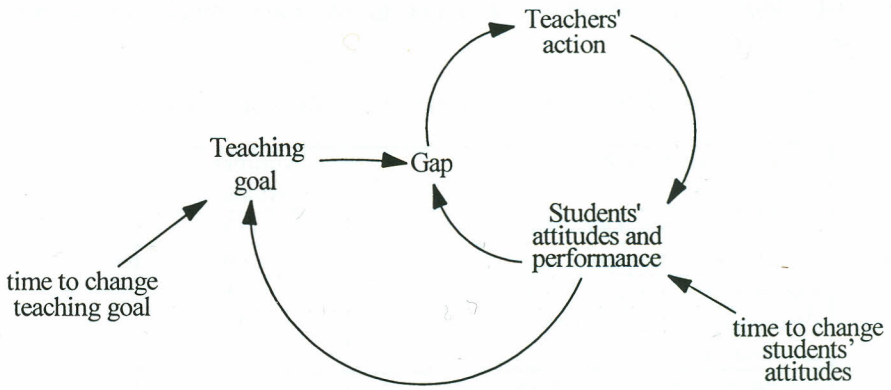

Figure 1. A continuous improvement system of teaching

Table 7. What the students like about the teaching practices in Informatics

What students like	Number of students
Internet	101
Help of senior students	95
Opportunity to work with computers	55
Help of teaching assistants	48
Systematic and thorough approach	44
Working with spreadsheet	39
Usefulness of teaching practice	31
Different software applications and their abilities	20
Interesting exercises	18
Relaxed atmosphere	17
Working with a word processor	13
Good organisation	8
Working in pairs	7
Practising basic knowledge	7
Other	16

In order to determine the disadvantages of the teaching practice and what would students change in this teaching practice we asked them two questions: (1) "What do you dislike about the teaching practice in Informatics?", (2) "What would you add to the teaching practices in Informatics?". The results are presented in Table 7 and Table 8. The student biggest coplaints were about how little time they had to practise and that they didn't have enough computers. A number of students complained about computers being obsolete, and most of these students have obtained substantial knowledge previously. Students with some or no previous knowledge complained that the teaching practices are too fast for those who have not obtained any knowledge

previously. Most of the students would like to add more Internet use to teaching practice in Informatics.

Table 8. What students dislike about the teaching practices in Informatics

What students dislike	Number of students
Time for practice is too short	133
Not enough computers	60
Obsolete computers	51
Practice is too fast for those who do not have previous knowledge	36
Not enough time for the Internet	27
Using an old version of Windows (3.11)	14
Senior students	12
Teaching assistants	11
Not enough senior students	9
Other	16

Table 9. What topics the students would add

Topics that students would add	Number of students
More Internet use	47
Computer graphics	12
Software engineering	12
Broader approach to existing topics	10
Windows 95	10
Creation of WEB pages	10

A survey of student attitudes to teaching practices in Informatics have indicated that there are problems with the current organisation of teaching practices. These are as follows:

- Students want more time to acquire more knowledge about IT and its application in business, especially about how to use the Internet.
- There is a large number of students that have some or no previous experience of using IT technology.
- There is also a large number of students that have excellent previous knowledge in using IT technology.

Because of these findings we have decided to propose the implementation of the following changes for the next school year. These changes refer to an investment in IT technology, to "teachers' actions" and to " a teaching goal":

- The computers should be upgraded to Pentium processors. Therefore, the Internet would be faster and students would have more effective time for working on-line. We could improve teaching practices by using the LCD panel, which could help students with some or no knowledge whatsoever to understand quicker and better exactly how they can use IT.
- For those students with excellent knowledge, we could use assignments that are more appropriate for their level of computer literacy.
- We have decided to increase the time for educating people about how to use the Internet, and we have introduced the design of Web sites into our curriculum.
- We have increased the number of senior students per section in order to help those students with less knowledge. In most of these sections it is hoped there will be three senior students that will help the teaching assistants.
- We have decided to maintain some Web pages that would serve as means of communication with our students. We shall also present some of the lectures on the Internet.

We have now implemented the second, the third and the fourth proposal, but because of restricted resources we could not implement the first one. At the end of the school year we shall conduct a survey of student attitudes again in order to see if the students think that the implemented changes are worthwhile.

5. THE IDEAL CONDITIONS FOR TEACHING PRACTICES IN INFORMATICS

We have considered the ideal conditions for teaching practices in Informatics. We can only imagine that such conditions will suit our teaching goals and suit the number of students we have in the Faculty of Economics where we work. First, we shall describe the current teaching conditions again.

There are 2,000 students involved in the first year course in Informatics and it is divided in 20 sections. There are approximately 100 students per section, 70 of whom come regularly. Every week each section has two-hour teaching practices. Currently, there are only three members of teaching staff that conduct these teaching practices. In other words, every one of them has to work with 6 or 7 groups of students or with 600 to 700 students. The teaching practices are conducted in only one computer lab with 20 computers with 486 processors. Therefore, we have to divide the students into two groups of roughly 35 students, and the students have to work in pairs. The class could not be held without the help of the senior students who prepare the classroom and help the students when they are having problems solving a given exercise. One additional problem is the really poor circulation of air in the computer lab, which is crowded throughout the day.

Ideally, there would be two computer labs with 30 multimedia computers with Pentium processors, which could easily run Windows 98 or NT. These computer labs would be updated every two or three years. Each teaching assistant would have to have an additional Pentium computer and there would have to be an LCD panel in each

class. Ideally, every computer would be up and running all the time, and there would be an effective virus protection system installed which would not interfere with the software that we would be working with. In every computer lab there would be a good conditioning system that would provide fresh air all the time. Students would be organised into small groups so that each student could work alone, and not with another student. Therefore, in each group there would be 45 students and if we presume that 30 students will actually come regularly (this is a realistic assumption since about 30% of our students work and study at the same time or at least claim to), so this would mean that for the 2000 students on the course there would be 45 groups of students and that the number of teaching staff that would conduct the teaching practices would be larger. There would be at least 9 teaching assistants and they would each give classes to 5 groups of students. We would not stop using the senior students' assistance, and we would presume that there would be at least one senior student helping each group of students. Finally, it would be ideal if every student had a personal computer at home and that they do their homework every week.

6. CONCLUSIONS

The most important "customers" for our first year Informatics course are the students, and we could measure our success in organising the teaching practices in Informatics by looking at their levels of satisfaction and knowledge at the end of the school year. According to our Survey and the data that is based on the student success in the exam, more than 70% of the students are satisfied with the teaching practice in Informatics and approximately the same number pass the practical part of the exam in Informatics. We hope that we have demonstrated that the teaching practices in Informatics can be successfully organised despite restricted resources, and this refers mainly to the large number of students using too few and obsolete computers. Also we have illustrated that a continuous improvement approach can be successfully applied in a university environment, and that it could be of use to the organisation of teaching practices in Informatics.

The continuous improvement system of teaching that we apply in the Department of Informatics at the Faculty of Economics has been presented in this report. The teaching staff at the University simply do not have enough data about their students, and the perceptions about student needs are not clear. Therefore, a system for collecting data must be established. Students' attitudes and performance must be compared with the teaching goals and their teachers' actions should also be taken into account so that we can achieve these teaching goals. The teaching goals should also be adapted in order to meet the students needs in a more efficient way. It is obvious that a continuous improvement system of teaching requires lots of work, but it is also obvious from our first hand experience that it is worth it. We are positive that what our course contains is now better aligned with the needs of our customers – the students.

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ORGANIZACIJA I UNAPREĐENJE PRAKTIČNE NASTAVE IZ INFORMATIKE

Sažetak

Članak se bavi pitanjem organizacije praktične nastave iz informatike čiji je cilj omogućiti studentima stjecanje odgovarajućeg nivoa informatičke pismenosti koja je ključna za uspjeh u današnjem poslovnom svijetu. Razmatraju se problemi organizacije praktične nastave u uvjetima ograničenih sredstava, kao i organizacija kontinuiranog unapređenja nastave u takvim uvjetima. Na primjeru organizacije nastave iz informatike na prvoj godini Ekonomskog fakulteta u Zagrebu demonstrirano je: (1) da se praktična nastava iz informatike može uspješno organizirati unatoč ograničenim sredstvima, koja se uglavnom odnose na premalen broj zastarjelih računala i (2) da se pristup kontinuiranog unapređenja nastave može uspješno primijeniti u organizaciji praktične nastave iz informatike. Detaljno je prikazan sustav kontinuiranog unapređenja nastave koji se primjenjuje na Katedri za informatiku Ekonomskog fakulteta u Zagrebu. Nastavnici na fakultetima najčešće nemaju dovoljno podataka o svojim studentima zbog čega imaju nejasnu predožbu o njihovim potrebama. Uspostavljen je sustav prikupljanja podataka čiji je cilj stjecanje uvida u stavove studenata, a koji se kontinuirano uspoređuju s nastavnim ciljevima. Kako bi ostvarili nastavne ciljeve, nastavnici prilagođavaju svoje akcije prema stavovima i uspješnosti studenata. Nastavni ciljevi trebaju se također povremeno mijenjati kako bi bolje odgovarali potrebama studenata. Očito je da sustav kontinuiranog unapređenja nastave zahtijeva mnogo rada. Međutim, nastava i nastavni ciljevi koji su bolje prilagođeni potrebama studenata svakako su vrijedni dodatnog truda.

Ključne riječi: informatičko obrazovanje, razvoj kolegija, kontinuirano unapređenje obrazovanja.