

On Innovation of Science Teacher Training and its Evaluation

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Abstract

Improving the quality of science education is unthinkable without a quality science teacher training at universities and other educational institutions. The paper deals with some innovation possibilities of the study programme for future science teachers realized within ESF project "Professional science teacher training for careers in a competitive environment" at Faculty of Science of Palacký University in Olomouc, Czech Republic. One of the main aims of the project is the creation of innovated curricula and special textbooks for these programmes. A complete evaluation was carried out to strengthen the feedback from pilot teaching of new and innovated subjects as well as the new teaching practice. The aim of the evaluation was to determine the difference between expectations and real benefits of the subjects and the practice. The evaluation results are very useful as a feedback for a subsequent modification of the study programs.

1. Introduction

According to Westat [7], the current view of evaluation stresses the inherent interrelationships between evaluation and programme implementation. Evaluation is not separate from, or added to, a project, but is rather part of it from the beginning. Planning, evaluation, and implementation are all parts of a whole, and they work best when they work together. Other interesting features of the evaluation process are presented by Lamanauskas [4], Bentley and Watts [1], Black and Wiliam [2] or Guba and Lincoln [3].

For an evaluation of process of science teaching and learning there are different strategy and ways. The main questions are: What is to be evaluated? When and why to evaluate? How to evaluate? It is clear that for science teaching success one of the most important resources is feedback from students (Lamanauskas, V., Vilkonienė, M., [5]).

2. Characterization of the project

The project objective is to improve the training of teachers of science subjects in line with the growing needs of the current competitive labour market. One of the main aims of the project leading to this improvement is the creation of innovated curricula for teacher training in mathematics, physics, chemistry, biology and geography at the Faculty of

Science at Palacký University in Olomouc, including a common base and teaching practice. Within this key activity new syllabi of some selected subjects were created and study textbooks were specifically treated for teaching these subjects. Pilot teaching of the innovated subjects is aimed at testing the innovated items on the target group of science teacher training students. A feedback based on the evaluation of the pilot teaching is used to modify the content of the final innovated subjects before their inclusion in regular study programme. Another objective of the project is the creation and development of university schools system in the region of Palacký University, in particular for the purpose of the implementation of the newly conceived student teaching practice. University schools will also be used to realize education research of students and university teachers and systematic work with potential applicants to study at the Faculty of Science at Palacký University.

The project target group consists primarily of students studying teacher training programme of natural sciences at the Faculty of Science, as well as secondary school students (potential applicants for the study at the Faculty of Science) and university teachers involved in training of the future teachers. The support for secondary school students is implemented within the project mainly by popularizing events, competitions, educational seminars, etc. Educational events thematically focused on the needs of teaching practice are organized for the target group of university teachers and students.

3. Evaluation of innovated teaching and teaching practice

The starting point for the evaluation was whether the teaching of new subjects which were integrated into study programmes would be helpful for students. Another question was whether the newly conceived concept of teaching practice would be more beneficial for students and also for their experienced supervising teachers than the old concept. The form of a questionnaire was chosen as a method of evaluation. Four research tools – questionnaires - were developed. Two were designed for evaluation of teaching and two for the evaluation of the teaching practice. The evaluation of the whole project is divided into the evaluation of the teaching of new subjects included in the study programme and the evaluation of the teaching practice in a new

concept. The first part of evaluation runs twice each semester, always at the beginning of the semester and at the end of the semester when those subjects are taught. The evaluation of the teaching practice is different. The teaching practice is also assessed twice; the first time from the perspective of a practicing student who gains teaching experience at school and the second time from the perspective of an experienced teacher with whom the student held the practice. These two forms of evaluation are always carried out at the end of the practice.

3.1. Partial evaluation of innovated teaching

Using the questionnaires during the evaluation of teaching of new subjects there were compared the expectations of students at the beginning of the course with the fulfilment of the expectations at the end, i.e. with their evaluation of teaching the subject throughout the semester. For this reason, the evaluation took place immediately at the beginning of teaching, i.e. in the first lesson of the subject. As a research tool, the questionnaire was used which investigated whether students expectations of this course were to acquire new knowledge, skills in practical or theoretical platform, whether they expected well-prepared teachers, and whether a motivation for choosing the subject was their interest. The evaluation questionnaire that students filled out at the end of teaching the subject, again carried the questions relating to the acquisition of new knowledge, and practical and theoretical skills. Other questions related to the quality of the professional preparedness of the teachers, the subject content - whether the students were interested in the subject, whether the form of implementation suited them, whether the issue was new and rewarding for them, whether they had enough quality literature and whether they would chose the subject again. Finally, the students rated the subject with a mark from 1 to 5, where 1 meant the best rating and 5 was the worst one. All questions except the last one were multiple-choice questions, the possible answers being: yes, partly, no, no answer. The questions were deliberately formulated with closed response options because of easier statistical processing. The questionnaires were designed as follows:

PRE-COURSE EVALUATION QUESTIONNAIRE

Circle your answer (one option only):

1. Do you expect that you acquire new knowledge by completion of this course?

yes	partially	no	no answer
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2. Do you expect that you acquire new skills by completion of this course?

yes	partially	no	no answer
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3. Do you think that you will get more:

theoretical knowledge	practical skills	just the same	no answer
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4. Do you expect well-prepared teachers?

yes	partially	no	no answer
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5. What was the reason for your choice of the subject?

credits	topic	teacher	other reason	no answer
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POST-COURSE EVALUATION QUESTIONNAIRE

Circle your answer (one option only):

1. Do you think that you have acquired new knowledge by completion of this course?

yes	partially	no	no answer
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2. Do you think that you have acquired new skills by completion of this course?

yes	partially	no	no answer
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3. Do you think that you have got more:

theoretical knowledge	practical skills	just the same	no answer
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4. Were the teachers well-prepared?

yes	partially	no	no answer
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5. Course content impressed you:

very impressed	moderately impressed	did not impress	no answer
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6. How do you meet the way of realization?

yes	I recommended to improve it	no	no answer
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7. Given issue was for you:

completely new	partially new	known (nothing new)	known (but rewarding)
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8. Quantity and quality of educational literature:

high	medium	low	no answer
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9. Would you choose this subject again?

definitely	maybe	no	no answer
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10. Mark of overall evaluation of the course (as at school)

1	2	3	4	5	no answer
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3.2. Partial evaluation of teaching practice

There were two questionnaires to assess the teaching practice. The first one investigated the perspective of a student who had just finished his/her teaching practice at school. Here the student was asked how he or she was prepared from university in terms of knowledge and skills in the subjects of his or her qualification. Further interest was to find out whether a student was informed about educational programmes used at school. Whether he or she was able to formulate the goals of teaching, to structure a lesson, whether he or she managed to motivate pupils properly, to have contact with them, to answer their questions, to evaluate their performance, to manage educational problems. Whether he or she managed to make appropriate use of information technology, whether he or she could prepare a written examination and conduct an oral examination, whether his or her speech was comprehensible for the students. In one of the items the student was asked whether the practice was used to collect data for educational research. The last item of the questionnaire provided the students with space to comment all activities which exceeded their duties. In the second questionnaire, filled out by an experienced teacher with whom the student held the practice, were items of similar content. The teacher used them to evaluate the student practitioner. All items except the last one offered options from 1 to 4, where 1 meant excellent and 4 unsatisfactory evaluation ratings. The research group for evaluation of the teaching was formed by all students who chose the subjects newly integrated into the study programme in the semester. Almost all the questionnaires in all new subjects were returned. It was because the teacher distributed the evaluation questionnaires at the beginning and at the end of the teaching practice personally and the students returned them to the teacher personally as well. The research group for evaluation of teaching practice in the new concept was formed by all students who realized their teaching practice in a given semester. Before starting the practice they received the evaluation questionnaires in both versions (for

themselves and their teachers) from their methodologist of qualification subjects which returned to their methodologist after the practice. This ensured an almost total return. The questionnaires were designed as follows:

QUESTIONNAIRE FOR TEACHER	1	2	3	4
1. He/She has sufficient knowledge and skills in the subject of his/her qualification and he/she is qualified to teach at secondary school:				
2. He/She was informed about the educational programs that are used at school:				
3. He/She was able to formulate the objectives and define the content of teaching in accordance with the appropriate educational program for each lesson:				
4. He/She was able to structure the lessons appropriately with regard to curriculum, timetable and the pace of study:				
5. He/She managed to properly motivate students and to reach their active participation in learning:				
6. He/She managed to make contact with students, communicate with them, use the standard language and the correct terminology. Pupils understood him/her:				
7. He/She managed to answer student's questions and solve professional problems:				
8. He/She managed to use information technology, suitable demonstrations and teaching aids:				
9. He/She managed to prepare a written tests and to lead an oral examination:				
10. He/She managed to evaluate the performance of students using appropriate classification without their comments:				
11. He/She managed to deal with educational problems:				
12. Clarity of his/her writing was for pupils:				

Figure 1. Teacher questionnaire for teaching practice

QUESTIONNAIRE FOR STUDENT	1	2	3	4
1. The school has prepared me in terms of knowledge and skills in the subjects of my qualification:				
2. I was informed about the educational programs that are used at school:				
3. I was able to formulate the objectives and define the content of teaching in accordance with the appropriate educational program for each lesson:				
4. I was able to structure the lessons appropriately with regard to curriculum, timetable and the pace of study:				
5. I managed to properly motivate students and to reach their active participation in learning:				
6. I managed to make contact with students, communicate with them, use the standard language and the correct terminology. Pupils understood me:				
7. I managed to answer student's questions and solve professional problems:				
8. I managed to use information technology, suitable demonstrations and teaching aids:				
9. I managed to prepare a written tests and to lead an oral examination:				
10. I managed to evaluate the performance of students using appropriate classification without their comments:				
11. I managed to deal with educational problems:				
12. Clarity of my writing was, in my opinion, for pupils:				

Figure 2. Student questionnaire for teaching practice

3.3. Data processing

The data obtained from the questionnaires were processed into tables and graphs with absolute and relative frequencies. A comparison of responses was made at the beginning and the end of lessons, if the subjects were in a sufficient number of respondents. Thus the difference between expectations and evaluations of the subject was assessed. Similarly, the items of student and teacher evaluation of teaching practice were compared. To observe anonymity it was necessary to use the two-sample (unpaired) method, and a nonparametric method according to the type of answers (see e.g. Lodico, Spaulding and Voeghtle [6]).

Using the Mann-Whitney test for the significance level of 0.05, statistically significant differences were investigated. The comparison could not be made in the cases where a sufficient number of respondents were not available. The evaluation was done using the system SPSS, version 12.0. Two evaluations of teaching and teaching practice were performed in the current phase of the project. In the first evaluation, teaching of the following new subjects was evaluated: Introduction to Study of Mathematics for Everyone, Current Issues of Teaching Mathematics, Fundamentals of Educational Research, Local Region in Teaching Geography, Current Issues of Teaching Geography and Current Issues of Teaching Physics.

When comparing the initial state and the final state of the subjects, no statistically significant difference was found. It can be established that new subjects met the needs of students. The practices of subjects Biology, Mathematics, Chemistry, Physics and Geography were evaluated within the first evaluation of the teaching practice. Connected answers of student and teacher responses were compared if a sufficient number of respondents were available. The chi-square test or the Fisher's test was used for the evaluation. If the requirements for these tests there were not fulfilled, the two-sample U-test was used. Everything was done using the system SPSS, version 12.0.

3.4. Partial evaluation results

A statistically significant difference was detected only for question number 1 in teaching Biology, where the students stated how they were prepared at university in terms of knowledge and skills for teaching the subject. The students were very critical and in 55% claimed that they did not have sufficient knowledge and skills in the subject of their qualification compared to 96% of teachers who were convinced that students had sufficient knowledge and skills to teach at secondary school. Within the teaching practice of chemistry, a statistically significant difference was determined between the

student and teacher response to the question regarding making contacts with pupils, communication with them and the use of the correct terminology. The students were convinced 100% that they spoke standard language, used the correct terminology and spoke clearly. However, the teachers argued that this was less than 60%. Within the teaching practice of geography, statistically significant differences were found in seven questions. The views of the students and the teachers diverged in their responses about whether the students had enough knowledge and skills for teaching their specialisation, about knowledge of educational programmes, about the skills to formulate an objective of teaching, to structure curriculum properly, about the ability to motivate pupils, the use of suitable demonstrations, teaching aids, information technology and about the ability to mark the students according to their performance.

Teaching of the following subjects was assessed within the second evaluation: Introduction to Study of Mathematics for Everyone (USM), Current Issues of Teaching Biology (SPVB), Revision of Secondary School Geography (RSZ), Revision of Secondary School Physics (RSSF), Revision of Secondary School Chemistry (RSCH) and Fundamentals of Educational Research (ZPV). When comparing the initial state and the final state of the subjects, no statistically significant difference was found. The second teaching practice regarded the following subjects: Biology, Mathematics, Chemistry, Physics and Geography. Again, connected answers of student and teacher responses were compared if a sufficient number of respondents were available. No statistically significant difference was found in any item of any subject.

4. Overall evaluation

The overall evaluation was realized after four semesters of innovated teaching and practice in a similar manner. The Table 1 shows the complete list of new courses taught during years 2011 and 2012. Besides of above mentioned courses, the following new courses were implemented into the study program during these two years: Current Issues of Teaching Physics (APVF), Current Issues of Teaching Chemistry (APVCH), Current Issues of Teaching Geography (APVZ), Dynamic Models of Stereometry (DMVS), Local Region in Teaching of Geography (MR) and Cross-cutting Topics in Teaching of Geography (PTZ).

Table 1. Innovated teaching – number of students

Course	Semester				Total
	1. 2011	2. 2011	1. 2012	2. 2012	
APVF	2	0	2	0	4
APVCH	0	0	6	0	6
APVM	6	0	8	0	14
APVZ	6	0	6	0	12
DMVS	0	0	9	0	9
MR	13	0	13	0	26
PTZ	0	0	0	25	25
RSCH	0	9	0	4	13
RSSF	0	5	0	2	7
RSZ	0	4	0	0	4
SPVB	0	15	0	32	47
USM	17	21	0	25	63
ZPV	1	0	0	3	4
Total	45	54	44	91	234

The course Study of Mathematics for Everyone (USM) was attended by the most students (63 students from the total number 234). The comparison of the responses to the questions 9 and 10 from the post-course evaluation questionnaire realized at the beginning and at the end of evaluation period is presented in the Table 2. A statistically significant difference for the usual significance level of 0,05 was detected only for the course Local region in Teaching of Geography (MR), question 10 (see Table 2.).

Table 2. Innovated teaching – comparison

Course	Question 9	Question 10
	<i>p</i>	<i>p</i>
APVM	0,089	0,082
APVZ	0,080	0,134
MR	0,014	0,069
USM	0,331	0,298
USM	0,674	0,227
USM	0,106	0,941
RSSF	0,527	0,823
RSCH	0,128	0,155
SPVB	0,327	0,137

The Figure 3 shows the overall evaluation of the newly implemented courses based on responses to the item 10 of the post-course questionnaire. One can

conclude that the implementation of the new courses is beneficial for students, because no average rating on a scale of 1-5 for any course is worse than the value of 1,8.

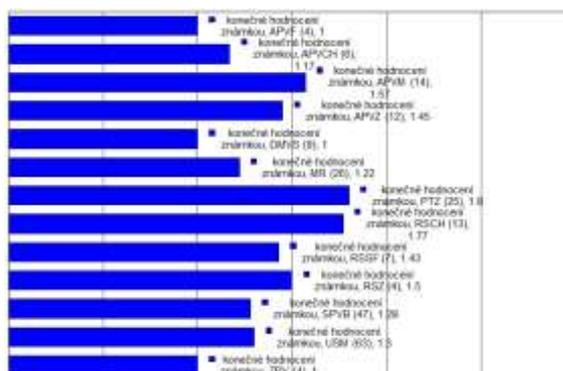


Figure 3. Overall evaluation of the courses

The comparison of responses to the items of the teacher questionnaire (Figure 1.) and student questionnaire (Figure 2.) was done within the evaluation of the teaching practice. The statistically significant difference between the teacher evaluation and the student evaluation of the teaching practice was detected for the items 1, 2 and 3 in geography and for the items 1, 2, 7 and 8 in biology. The students expressions were more critical than teachers ones in all cases.

5. Conclusions

A general conclusion can be achieved from the evaluation: the implementation of new subjects was successful and met the expectations of the students. The new approach to the teaching practice has resulted in a stronger feedback and the subsequent creation of conditions for improvement of the practice. A scientific conference on the issue of education of science branches teachers will be organized at the end of the project. Further experience with innovated teaching and results of its evaluation should be presented. As it is usual for ESF projects, the outputs of the project should be sustainable for several years. Therefore, as well as because of the positive results of the evaluation, it is the intention of the realization team to implement new subjects as a permanent part of the study program.

6. References

[1] D. Bentley, D. M. Watts, *Communicating in School Science: Groups, Tasks and Problem Solving*, Falmer Press, London, 1992.

[2] P. Black, D. Wiliam, "Assessment and classroom learning". *Assessment in Education*, 5 (1), 1998, pp. 7-74.

[3] E. G. Guba, Y. S. Lincoln, *Effective evaluation*, Jossey-Bass, San Francisco, 1981.

[4] V. Lamanauskas, "The Evaluation Strategies of Integrated Science Teaching and Learning". *Problems of Education in the 21st Century*, 31, 2011, pp. 5-6.

[5] V. Lamanauskas, M. Vilkoniené, *European Dimension in Integrated Science Education (Training Material for Students)*, Palacký University Press, Olomouc, 2008.

[6] M. G. Lodico, D. T. Spaulding and K. H. Voeghtle, *Methods in Educational Research*. Jossey-Bass A Wiley Imprint, San Francisco, 2010.

[7] J. F. Westat, *The 2002 User Friendly Handbook for Project Evaluation*, National Science Foundation, 2002.

7. Acknowledgements

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