

Chapter # 33

IMPACT OF TEACHER CREATIVITY STYLES ON SCIENCE TEACHER TRAINING IN INQUIRY-BASED SCIENCE EDUCATION

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ABSTRACT

The efficiency of teacher education is an essential issue in continuous professional development. The main areas affecting this efficiency are innovative educational methods, teacher training methods and personality characteristics, including creativity styles. The study is devoted to researching the roles of teacher creativity styles in science teacher training in implementing inquiry-based science education. The research was conducted in the frame of the European project PROFILES. Design-based research has been used as a research frame. Fifty Czech science teachers - participants in the PROFILES project were identified as innovators using Kirton Adaption-Innovation Inventory. A comparison of teachers' activities during training with characteristics of teachers-innovators was conducted. The research results confirmed teachers' innovative behaviour during the training of IBSE implementation. The main research finding is that the style of creativity (innovators) influenced the interest and process of teacher training. The research implies that it is necessary to accept the creative style of teacher-participants in training courses to be efficient.

Keywords: creativity style, efficiency, inquire-based science education, science education, teacher education.

1. INTRODUCTION

A significant problem of teacher education is its efficiency. Several projects focused on teacher continuous professional development (hereinafter CPD) meet with this problem and try to solve it. Inefficiency is the crucial failing of teacher CPD confirmed by numerous studies. Raymond (1997) monitored teachers for four years to see whether they implemented innovative teaching methods acquired in teacher training into classroom practice. Most of them reduced the frequency of implementation of these new methods with each passing year and returned to those ones used before teacher training (Trna, Trnova, & Sibor, 2012; Duffy & Roehler, 1986; Fullan, 1991; Constantinou, Tsivitanidou, & Rybska, 2018). Similar results were obtained in the four-year study (Stallings & Krasavage, 1986) because teachers implemented new methods and desired behaviours in the fourth year much less often than in the first two years. According to Meyer (1988), the implementation level of new educational methods presented to teachers in short training programs with only a few hours of workshops and limited follow-up activities is estimated at only about 15 percent.

The efficiency of teacher CPD was also at the centre of interest of the PROFILES project (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) funded by the FP7 programme of the European Commission (PROFILES, 2015). The project PROFILES was aimed to promote inquiry-based science education (hereinafter IBSE) as a component of teaching/learning. Teachers-participants in the PROFILES project underwent a teacher CPD programme (hereinafter PROFILES CPD),

which was described in detail in the study (Bolte, Holbrook, & Rauch, 2012). Teachers went step by step through this PROFILES CPD in four roles: teacher as a learner; teacher as a teacher; teacher as a reflective practitioner; teacher as a leader. This study presents results from the PROFILES CPD phase in which teachers acted in the role of teachers as learners and underwent education based on IBSE to develop their professional knowledge and skills as well as creativity.

The intent of this contribution is to describe of achieving greater efficiency of the PROFILES CPD based on the study of roles of teacher creativity styles in science teacher training in IBSE. Earlier research on this topic incentivised for this focus on teacher creativity (Trnova & Trna, 2014; Trnova, Kopecka, & Trna, 2014).

2. BACKGROUND

2.1. Paradigm of research

The paradigm of this research is the belief in the crucial role of creativity and its development in the education of students and teachers. Our core statements of creativity are:

- Creativity is a specific mental capacity where creative thought is divergent (Guilford, 1950, 1980).
- Creativity can be developed (Fryer, 1996; Parnes, 1963; Torrance, 1963; Torrance & Myers, 1970).
- Everyone has the potential to be creative (Craft, 2001; Esquivel, 1995; Feldman & Benjamin, 2006; Kaplan, 2019; NACCCE, 1999).
- Factors of creativity (Guilford, 1950, 1980; Torrance, 1963, 1974): fluency, flexibility, originality, elaboration, redefinition, and sensitivity to problems.

Since the end of the 1990s, creativity has become the centre of interest within education and wider society (Craft, 2005). In the world of technological and scientific development, human skills and especially creativity are essential resources (Robinson, 2001; 2012; Tekmen-Araci, & Mann, 2019).

Now creativity plays a crucial role also in education as relevant competency for the 21st century (Robinson, 2006; Robinson, 2012; Rocard et al., 2007) and needs to be included in education as a fundamental life skill (Craft, 1999) which is necessary for surviving and prosperity of future generations in the 21st century (Parkhurst, 1999). A significant fact is that developing creativity through education is confirmed by many studies (Lin, 2011; Kaplan, 2019).

According to experts' findings, teacher creativity is important for developing student creativity (Amabile, 1996; Craft, 2005; Gryskiewicz, 1982; Lin, 2011; Sternberg, 1999). Most of the teacher creativity is manifested in teachers' creative work with the subject content as a creative educational practice (Barbot, Besançon, & Lubart, 2011). Through their creativity, teachers affect the creative development of their students. Creative education is an intentional activity with specific methods and setting conditions to make these methods effective. Creativity is also a crucial factor in the multidimensional development of teacher professional competencies.

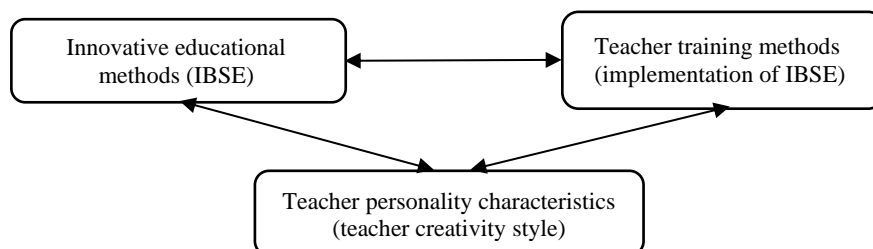
2.2. Areas of limiting teacher CPD

Limiting factors of teacher education (CPD) were examined in three essential areas:

- Innovative educational methods (focused on IBSE)
- Teacher training methods (focused on the implementation of IBSE)
- Teacher personality characteristics (focused on teacher creativity style)

These three areas comprise several factors which also interact (see Figure 1).

Figure 1.
Areas of limiting teacher CPD.



These three areas correspond to the three-working hypothesis of limiting the sources of inefficiency in teacher CPD:

- The cause of the low efficiency of teacher education is inappropriate innovative educational methods (teachers do not consider the methods to be helpful)
- The cause of the low efficiency of teacher education is inappropriate teacher training methods (authors of teacher training courses ignore the educational needs of teachers)
- The cause of the low efficiency of teacher education is inappropriate teacher personality characteristics (e.g., teacher cognitive and creativity style)

The study takes a closer look at the third area, which contains teacher personality characteristics. Teacher styles of creativity were selected for the detailed research.

2.3. IBSE PROFILES CPD

All three limiting factors could occur in the PROFILES CPD. Providers of the PROFILES CPD tried to minimize the negative impact of all limiting factors. Developing teacher creativity was also one of the preventive procedures in these efforts (Bolte et al., 2012). Essential components (Craft, 2005; Lin, 2011) of creativity were supported by core factors of IBSE (such as a stimulating environment, connection with problems of everyday life, instruction based on inquiry, teamwork, and strong motivation).

IBSE seems to be the appropriate way to develop teacher and student creativity because it involves many components of creativity and its development (Trnova et al., 2014; Alake-Tuenter et al., 2012). Teachers play in IBSE the role of special adviser and guide for students (Cairns & Areepattamannil, 2019). They encourage unusual ideas and solutions, and they allow mistakes. So, they create a creative environment (Banchi & Bell, 2008; Nunaki, Damopoli, Kandowangko, & Nusantri, 2019). Teachers-participants in the PROFILES project first passed the PROFILES CPD based on IBSE as learners, and after it, they implemented IBSE in their schools as teachers. They created their IBSE school programme - IBSE modules. Using IBSE as the core component of the PROFILES CPD, their professional knowledge, skills, and creativity were developed.

2.4. Styles of creativity

For this study, it is necessary to briefly describe the style of creativity. Kirton's Adaptation-Innovation Inventory (hereinafter KAI) is a measurement tool of the KAI theory (Kirton, 1987, 1994; Kubes, 1998). The KAI inventory was developed to measure differences in cognitive styles - creativity styles. According to the points individuals get in KAI, it is possible to include each of them in one of two groups, adaptors or innovators (Kirton, 1994). Everyone can be located on a continuum ranging from highly adaptive (adaptor) to highly innovative (innovator).

Highly innovative individuals (innovators) prefer to do things differently, to challenge the paradigm or structure. They are sometimes seen as undisciplined, thinking tangentially, and approaching tasks from unexpected angles. They bring radical solutions to problems. If the teacher is unaware of the different styles of students' creativity, the student with the features of an innovator can be considered naughty or unruly.

Highly adaptive individuals (adaptors) prefer to improve things while working within the given paradigm or structure. They are characterized by precision, reliability, efficiency, discipline, and conformity. They are sometimes seen as both safe and dependable in their work. Adaptors reduce problems through improvement and greater efficiency (Kubes, 1998; Puccio, 1999).

To put it shortly, innovators "do things differently", and adaptors "do things better" (Kirton, 1987; Puccio, 1999). Individuals possess a share of each style; however, each of us prefers one style to the other (Gregorc, 1979). Each style has specific strengths and weaknesses (see Appendix 1). One style is not better than the other; both styles are useful. According to Šorgo et al. (2012), adaptors could be better at creative teaching and inventors (innovators) at teaching creativity.

The creativity style of a teacher is outside the centre of attention. In doing so, a teacher's creativity style can significantly influence the work of a teacher. This study focused on a teacher's creativity style's effect on his/her education.

A comparison of teachers-innovators and teachers-adaptors characteristics was made with these results:

- Both teachers-innovators and teacher-adaptors are creative, the only difference is how they express their creativity.
- Teachers-adaptors operate within a framework of systems. They are associated with enough originality, efficiency, and rule-group conformity. In comparison, teachers-innovators break away from the existing framework of systems, and they are associated with high-interest levels in terms of the originality of ideas. However, they are less interested in efficiency and rule group conformity.
- Teachers-adaptors tend to produce fewer implementable solutions to problems and are more compliant and bureaucratic within the workgroup. In contrast, teacher-innovators tend to be brimming with ideas, flout rules, and display little regard for bureaucratic details (Bagozzi & Foxall, 1995).
- Teacher-adaptors prefer to create change by improving the existing structure and favour staying in groups (Kirton, 1994). In addition, they maintain cohesion by following the accepted ways and prefer to solve problems in a disciplined, methodical, and predictable manner.
- On the other hand, teacher-innovators often come up with many new and practical ideas and are risk-oriented. They prefer to stay as individuals and create change by altering the existing paradigm (Kirton, 1994).
- Teachers-innovators are better in creating suitable learning environments supporting task-involvement of students than teachers-adaptors. (Ee, Seng, & Kwang, 2007).
- Educational methods that are not routine for teachers require the approach from new angles and to think divergently: teachers-innovators are better in their implementation in education than teachers-adaptors (Brophy, 1998; Runco, 1994).
- IBSE, as innovative educational method, needs both innovators (IBSE guided and open levels) and adaptors (IBSE confirmation and structured levels).
- Teacher-innovators and teacher-adaptors who operate at opposite ends of the continuum might have difficulty working together. Due to significant differences in thinking and working style, a conflict between the teachers-adaptors and teachers-innovators in group work could arise. To prevent such conflict, which can

disrupt the good work of the team, it is important to know the style of creativity of members of the team (Kirton, 2000).

The most important result is that teacher-adaptors prefer to behave differently from teachers-innovators, as it is against their nature to solve problems by bending the rules. Similarly, teachers-innovators prefer to behave differently than teacher-adaptors, as it is against their nature to solve problems by following rules (McHale & Flegg, 1986). This fact must realize by implementers of teacher CPD. It is necessary to choose different approaches to CPD adaptors and innovators. This fact has been detected within the PROFILES CPD.

3. METHODOLOGY OF RESEARCH

3.1. General background of research

Increasing the efficiency of teacher CPD of innovative educational methods was the general research problem. Under the above facts about the areas of limiting teacher CPD, this study attempted to solve a part of the major research problem, how to increase the efficiency of science teacher training with an innovative educational method – IBSE. Studied the limiting factor is the teacher's creativity style.

Research question

The study focused on a specific part of this general research problem, which was formulated in the research question:

How to increase the efficiency of teacher training in the implementation of IBSE using teacher creativity styles?

Sample

The sample consisted of 50 science teachers of lower and upper secondary schools in the Czech Republic - participants in the PROFILES CPD in 2011-2014 (Table 1). The subject, gender, and experiential composition of the sample were as follows:

*Table 1.
Sample selection - PROFILES - Czech Republic.*

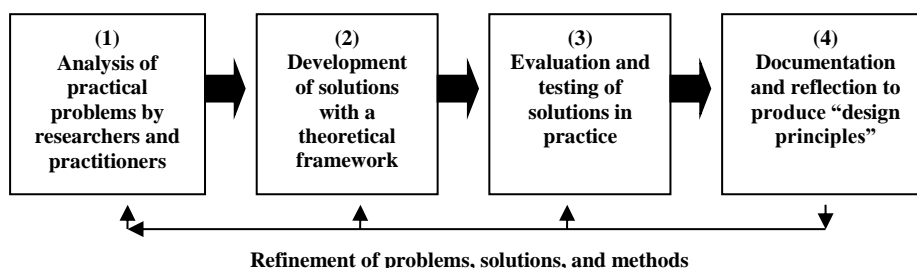
Subject of teaching	N	Gender of teachers	N	Teaching experience of teachers	N
Total	50		50		50
Physics	16	F	41	0-5 y	6
Chemistry	16	M	9	5-15 y	19
Biology	18			15 y and more	25

These teachers were not chosen randomly but based on their interest in being involved in the project. These teachers work in schools with different numbers of students and classes. Their schools were located in a large cities, small towns and villages.

3.2. Research instruments and procedures

Design-based research (hereinafter DBR) was the basic framework of the research. DBR (Reeves, 2006) is a development research approach which can be described as a cycle: (1) analysis of a practical problem, (2) development of solutions, (3) evaluation and testing of solutions in practice, and (4) reflection and production of new design principles (Figure 2).

Figure 2.
Scheme of design-based research (according to Reeves, 2006).



In the study, these steps have the following forms:

(1) *Analysis of practical problems*: detection of creativity styles of teachers-participants in the PROFILES CPD; identification of roles (risks) of teacher creativity styles in science teacher training in the implementation of IBSE.

(2) *Development of solutions with a theoretical framework*: creating of the PROFILES CPD appropriate to teachers with different creativity styles; using teacher creativity styles to enhance the efficiency of teacher CPD.

(3) *Evaluation and testing of solutions in practice*: testing of modified the PROFILES CPD with the respect to different teacher creativity styles.

(4) *Documentation and reflection to produce "Design principles"*: documentation and establishment of the design principles for the increasing of efficiency of teacher CPD with the respect to different teacher creativity styles.

Within DBR, research methods and tools were used in the study: case study, structured observation, questionnaire, structured interview, analysis of teachers' products. These include special methods, mainly KAI and comparative analysis (comparison the PROFILES CPD activities and characteristics of teachers-innovators) which are described in more detail:

KAI: To determine the style of teacher creativity standardized method of Kirton's Adaptation-Innovation Inventory (KAI) was applied (Kirton, 1994). KAI lists three facets that correspond to three-factor traits:

(1) Sufficiency of originality refers to a preference for producing a few implementable solutions to problems.

(2) Rule governance concerns a social tendency to maintain workgroup cohesion by doing things in accepted ways.

(3) Efficiency refers to a bureaucratic concern with being exact, systematic, and disciplined.

Kirton's standardized questionnaire validated in research in the Slovak Republic was applied and administrated to the participants exactly according to instructions described in (Kubes, 1992, 1998). The questionnaire developed by Kubes (1992, 1998) was translated into the Czech language. Although the Czech and Slovak languages are very close, an expert carried out the translation for both languages.

Comparison of teachers' the PROFILES CPD activities and characteristics of teachers-innovators:

A comparative analysis of the activities of teachers during the PROFILES CPD and characteristics of teachers-innovators has been made. Sixteen special teacher activities in the PROFILES CPD focusing on IBSE were discovered during this comparative analysis (see Table 2). These activities have become categories for detailed observation scheme of teachers' PROFILES CPD activities.

Table 2.
Comparison teachers' the PROFILES CPD activities and characteristics of teachers- innovators.

<i>Teachers' PROFILES CPD activities</i>	<i>Characteristics of teachers-innovators according to (Ee & Tan, 2009)</i>
1 Teachers chose unusual topics of IBSE; they unexpectedly responded to suggestions of other teachers.	Innovator seen as thinking tangentially, approaching tasks from unsuspected angles; undisciplined, unpredictable.
2 Teachers anticipated problems that might arise when teaching based on IBSE and proposed unusual solutions.	Innovator tends to discover problems as well as less expected avenues of solution.
3 When solving problems - processing into IBSE form - teachers did not act on proven teaching strategies, on the contrary, they rather questioned them.	Innovator tends to question a problem's concomitant assumptions; manipulates problems.
4 During teamwork, teachers behaved individually and presented their opinions but did not create standard outputs.	Innovator is catalyst to settled groups, irreverent of their consensual views; seen as abrasive, creating dissonance.
5 Teachers were not afraid to experiment, to risk failure. They were fearless in putting into education even higher levels of IBSE.	Innovator in solving problems, seeks to explore untested areas that may be risky and jeopardize the situation.
6 In discussions, particularly some teachers hard defended their views on teaching methods based on IBSE used by them.	Innovator shows less respect for others' views, more abrasive in presenting solutions.
7 Teachers were delighted that they could teach "according to themselves."	Innovator does things differently.
8 Teachers suggested unusual educational aids, and they invented new experiments.	Innovator in pursuit of goals is liable to challenge accepted means.
9 During the four years of the PROFILES CPD, teachers changed already created modules IBSE - they taught them differently. They created new modules.	Innovator is usually unable to stay on detailed routine (system maintenance) work for longer than short bursts, quick to delegate routine tasks.
10 Teachers easily coped with the problems that arose in teaching/learning based on IBSE; they improvised.	Innovator tends to take control in unstructured situations.
11 At the beginning of the PROFILES CPD, there were problems with abiding by the rules for creating modules IBSE. Teachers changed the recommended structure of IBSE modules and experiments.	Innovator often challenges rules; may have little respect for past customs.
12 A popular method of teachers was brainstorming - they had many ideas, but were unwilling to implement the ideas of others; they preferred their own ones.	Innovator appears to have low self-doubt when generating ideas, not needing consensus to remain steadfast in face of opposition; less certain when placed in core of system.
13 During IBSE, teachers managed very well the new situation, even when using IBSE modules for the first time.	Innovator is ideal for tackling unscheduled crises in the institution, or for helping to avoid them, if can be trusted by adaptors.
14 Teachers wanted a change - they liked creating their own modules more than using already created ones.	Innovator appears insensitive to people when in pursuit of solutions, hence often threatening group cohesion and cooperation.
15 Teachers liked that they could use new methods to teach obligatory topics differently.	Innovator provides the dynamics to bring about periodic radical change, without which institutions tend to become rigid.
16 Teachers wanted to stand out; they tried to make their modules not only quality but also original. They were creating groups of teachers in schools who used their modules.	Innovator tends to adopt mastery goal orientation.

Observation of teaching activities took three years, and object of observation was 50 of the same teachers.

3.3. Data Analysis

The research yielded much data. For clarity, we show the results of KAI and Comparison teachers' the PROFILES CPD activities and characteristics of teachers-innovators.

KAI: There were 32 items in the KAI instrument. Each item was scored from one to five points. The theoretical measurement interval is between 32 and 160. As a result of the administrations by the researchers, the scores were generally found to vary between 46 and 145. The average score is 96 (Kirton, 1987, 1994, 1999). A person with an adaptive cognitive style will score in the 60-90 range. Someone with an innovative style will score between 110 and 140 (Mudd, 1996). The KAI scale was found to be reliable ($\alpha = 0.94$).

Comparison of teachers' PROFILES CPD activities and characteristics of teachers-innovators: They were used conventional methods of data processing for the structured observation, with the support of data from product analysis (portfolio) and structured interviews. Special data analysis was compiled in the form of the table of the PROFILES CPD activities of teachers-innovators in binary code (see Appendix 2, 3).

4. RESULTS OF RESEARCH

KAI: Styles of the creativity of teachers-participants of the PROFILES CPD in the Czech Republic were determined using the KAI inventory. Scores of the KAI (hereinafter sKAI) inventory of Czech teachers-participants of the PROFILES CPD were between 101 and 132. Their scores are presented in Table 3. All scores of the Czech teachers were higher than the average score (96) presented in the literature. Their average score was 113.9. According to Mudd (1996), only eight persons were not in the interval (110 - 140) for the pure innovative style, but their scores were above the interval (60-90) for the adaptive style. Therefore, they were rightfully included among the innovators.

Table 3.
Scores of the KAI (sKAI) inventory of PROFILES - Czech teachers (N = 50).

sKAI	101	105	105	106	107	107	108	109	110	110
sKAI	110	110	110	111	111	111	111	111	112	112
sKAI	112	112	112	113	113	113	113	114	114	114
sKAI	115	115	115	116	116	116	116	117	117	118
sKAI	118	119	119	120	121	123	124	124	125	132
Average score						113.86				
Median						113				
Standard deviation						5.71				
Variance						32.64				

Based on the above criteria, it can be concluded one teacher has shown a strong preference for innovativeness (sKAI 132). Seven teachers exceeded the "limit" of 120 points; they could be considered "very strong" innovators. Ten teachers exceeded by only 1-2 points the "limit" (110 points) for innovative style. Eight teachers (sKAI 101-109) exhibited characteristics of both adaptive and innovative styles and were not "pure" innovators. According to average scores, teachers possess a preference for innovative style. According to experts, individuals possess varying degrees of both styles. During the CDP, teachers

exhibited characteristics of both the adaptive and innovative styles, but commonly they preferred to “do things differently” as teachers-innovators.

We can state that Czech science teachers-participants of the PROFILES CPD can be considered innovators. In our opinion, the reason for this result is that the PROFILES CPD participants were teachers who want to 'change' their teaching, which is a fundamental characteristic of innovators. These results of our research partly surprised us. This finding led us to carry out a second part of the research, in which it was possible to determine whether teacher-innovators behaved as innovators in real situations during CPD.

Comparison the PROFILES CPD activities and characteristics of teachers-innovators: Comparative analysis of the activities of teachers during the PROFILES CPD and characteristics of teachers-innovators yielded results that at the maximum number of points 16, the average score was 12.94 points and the median 13 points (see Appendix 2, 3).

Table 4.
Scores of the comparison of the PROFILES CPD activities of teachers (N = 50) and innovators characteristics.

Average score	12.94
Median	13
Standard deviation	1.59

These 16 activities (categories) were studied in detail for three years using complex observation and analysis of teachers' portfolios. Interviews with the teachers confirmed their results and brought information about their conscious self-reflection. The project resulted in the finding that there has been a significant increase in teachers' ownership.

5. DISCUSSION

The research question was asked about the role of the teacher creativity style in teacher CPD focused on IBSE.

The research presented in the context of DBR brought several key findings, which now are commenting:

- *The interest of Czech science teachers about the PROFILES CPD, based on implementation of IBSE, was significantly influenced by their creativity style.*

Similar findings were observed during the CPD in other countries participating in the PROFILES project. Many teacher-participants from other countries in the PROFILES project showed traits of innovators. We can assume that teachers' creativity style influences teachers' CPD interest in innovative educational methods such as IBSE. Due to the small number of teachers observed and the specific training of teachers in IBSE, the research is a case study in nature. This research should establish follow-up correlational research to verify the difference in the interest of teacher-adapters and teacher-innovators participating in CPD for innovative teaching methods in education.

- *The design of teacher CPD must be modified by the creativity style of teachers.*

During the three-year of the PROFILES CPD, teacher education design was modified by teachers' creativity style. In the case of Czech teachers-innovators, passive lectures were limited, were extended independent activity of teachers, teachers were able to come up with new ideas, was strengthened personal communication etc. The main outcome of the creative activity of teachers-innovators was their new teaching/learning PROFILES modules. CPD makers might consider teachers' creativity styles and modify the training course according to the creativity styles of the teachers-participants.

- *Teachers-innovators (participating the PROFILES CPD in the Czech Republic) constantly use innovative teaching methods in their practice. It showed an increase in their ownership and permanent and functional obtaining of high-quality professional competencies to implement IBSE.*

This finding must be verified during research on a larger sample of teachers of various subjects. A long-term study which would confirm the persistence of teacher knowledge about innovative methods and the frequency of their implementation in education would be appropriate. If the finding is confirmed, the efficiency of CPD may increase due to modification of CPD according to the teacher's creativity styles.

- *Most teachers-innovators become teachers-leaders and disseminate innovative methods (IBSE) among other teachers, who were not participants of the PROFILES CPD.*

Due to their personality characteristics, including creative style, these teachers-innovators have significant potential for disseminating innovative educational methods (e.g., IBSE) in their schools, particularly among teachers-adaptors. So, there is a multiplier effect of the increase in innovation instead of the expected decline. Further research should focus on the relationship between the personality characteristics of teachers and their leadership position in CPD.

6. CONCLUSIONS AND IMPLICATIONS

A serious problem of teacher CPD is its low efficiency. Many projects and other activities in teacher education and innovation will be wasted. It is a problem not only of education quality and development but also financially. Resources invested in teachers' CPD must bring the expected outcomes.

As stated above, many factors influence teacher education's efficiency. This study focused on the influence of the creativity style of science teachers on the efficiency of their CPD. Within the project PROFILES, the Czech Republic has arisen in a situation where all participants CPD signalled the creative style of teacher-innovator. The comparative analysis was used, which confirmed that teachers-innovators have special educational needs, and their behaviour matches their creativity style - innovator.

The main output of the research is the finding that teacher creativity style is a factor which influences science teacher education. Research shows that teacher creativity style impacts on the progress and efficiency of teacher CPD for science teachers. At the core of the DBR are the following:

- Teacher creativity style is the factor fostering teacher education.
- The result (nearly 13 points from 16 maximum achievable in comparative analysis) confirmed that teachers-innovators behave really like innovators in teacher training in IBSE implementation.
- It is necessary to develop and implement CPD courses consider the personal characteristics of the individual teacher-participants – especially creativity style.

These results obtained in the frame of the PROFILES project for a sample of 50 Czech science teachers can be considered evidence. Since this descriptive research has features of a case study, it is necessary to complement it with the other broader and long-term research that has just commenced.

Significant creativity development of teachers-participants of the PROFILES CPD was discovered as additional research implications. The study verified that IBSE is suitable for developing teacher and student creativity. There is an overlap between factors supporting creativity and the core principles of IBSE (Trnova & Trna, 2012).

Teachers' creating new curricular materials for IBSE (modules) was a comprehensive expression of the increase in the teachers' creativity level. According to research observation, content analysis of data and structured interviews, each participant improved, in accordance with the definition of creativity, his/her abilities (participants created new materials etc.), individual approach (teachers changed worksheets etc.) and process (teachers worked very hard etc.).

Another complementary output of the study of teacher creativity style is finding about creativity styles, which is an important factor for teamwork (Kirton, 1994) in the frame of teacher CPD. This aspect needs to be addressed, and it may be one reason for the inefficiency of teacher CPD.

Diagnosis of teacher creativity styles benefits cooperation with other participants of CPD in the task of problem-solving. To communicate effectively, individuals must understand the tendencies and potential of other team members. This knowledge helped to collaborate more effectively among all stakeholders in the PROFILES CPD.

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Short biographical sketch: Eva Trnová is an associate professor at the Faculty of Education of Masaryk University in the Czech Republic. She studied chemistry at the Faculty of Science of Masaryk University. She completed her doctoral studies in the field of chemistry education and completed her habilitation in pedagogy. She has been engaged in education for a long time and has published monographs and magazine articles on this issue. She dealt with issues related to the chemistry teacher curriculum and continuing professional development (CPD) for chemistry teachers at all levels of education. She is a member of Hands-on Science and the International Council of Associations for Science Education. She participated in the organization of several international conferences. She participated in many international projects dealing with chemistry education research and science education development (e.g. PROFILES, Project of SFP, STAR). Recently, she has been working on the issue of gifted education.

Appendix 1.

A list of core characteristics of adaptors and innovators (Ee & Tan, 2009, p. 59).

Adaptor	Innovator
Characterized by precision, reliability, efficiency; seen as methodical and disciplined.	Seen as thinking tangentially, approaching tasks from unsuspected angles; undisciplined, unpredictable.
Concerned with resolving problems rather than finding them.	Tends to discover problems as well as less expected avenues of solution.
Seeks solutions to problems in tried and understood ways.	Tends to question a problem's concomitant assumptions; manipulates problems.
Lessens problems through improvement and greater efficiency with maximum of continuity and stability.	Is catalyst to settled groups, irreverent of their consensual views; seen as abrasive, creating dissonance.
Disciplined in solving problems with minimum of risk.	In solving problems, seeks to explore untested areas that may be risky and jeopardize the situation.
More loyal to policy of consensus.	Shows less respect for others' views, more abrasive in presenting solutions.
Seen as conforming and dependable.	Seen as ingenious, unsound, impractical.
Does things better.	Does things differently.
Liable to make goals of means.	In pursuit of goals, liable to challenge accepted means.
Seems impervious to boredom and able to maintain high accuracy in long spells of detailed work.	Usually unable to stay on detailed routine (system maintenance) work for longer than short bursts, quick to delegate routine tasks.
Is an authority within given structure.	Tends to take control in unstructured situations.
Challenges rules rarely, cautiously, when assured of strong support and problem solving within consensus.	Often challenges rules; may have little respect for past customs.
Has high self-doubt when system is challenged, reacts to criticism by closer outward conformity; vulnerable to social pressure and authority; compliant.	Appears to have low self-doubt when generating ideas, not needing consensus to remain steadfast in face of opposition; less certain when placed in core of system.
Essential to the functioning of the institution all the time, but occasionally needs to be "dug out" of the current systems.	Ideal for tackling unscheduled crises in the institution, or for helping to avoid them, if can be trusted by adaptors.
When collaborating with innovators, provides stability, order, and continuity to the partnership	When working with adaptors, provides task orientations and the break with past and accepted theory.
Sensitive to people, maintains group cohesion and cooperation; can be slow to overhaul a rule.	Appears insensitive to people when in pursuit of solutions, hence often threatening group cohesion and cooperation.
Provides a safe base for the innovator's riskier operations.	Provides the dynamics to bring about periodic radical change, without which institutions tend to become rigid.
Has a conscientious personality trait.	Has an extroverted personality trait.
Tends to adopt ego avoidance orientation.	Tends to adopt mastery goal orientation.

Impact of teacher creativity styles on science teacher training in inquiry-based science education

Appendix 2.
Scores of the comparison of the PROFILES CPD activities of teachers-participants
(N = 1-25) and teachers-innovators characteristics.

	No of teacher	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	
No of PROFILES CPD activity																											
1		x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x	x	x	-
2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3		x	x	x	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x
4		x	x	x	-	x	-	-	x	-	x	-	x	-	x	-	x	x	x	x	x	x	-	x	x	x	x
5		x	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	-	x	x	x	x	x	x	x	x	x
6		x	x	-	x	-	x	x	-	x	-	-	x	-	x	x	x	x	x	-	-	-	x	-	-	-	-
7		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
8		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
10		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
11		x	x	x	x	x	x	x	x	x	-	x	x	x	-	x	-	-	-	-	-	-	x	-	-	-	-
12		x	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	-	x	-	-	-	x	x	x
13		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
14		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
15		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
16		x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	-	x	-	-	x	-	-	x	-	-	x
TOTAL		16	16	15	15	15	15	15	15	15	14	14	14	14	14	14	14	14	14	14	13	13	13	13	13	13	13
Percentage		100	100	93.8	93.8	93.8	93.8	93.8	93.8	93.8	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	87.5	81.3	81.3	81.3	81.3	81.3	81.3	81.3	

Appendix 3.
Scores of the comparison of the PROFILES CPD activities of teachers-participants
(N = 26-50) and teachers-innovators characteristics.

	No of teacher	26	27	28	29	30	32	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
No of PROFILES CPD activity																											
1		x	-	-	x	x	-	x	x	x	x	-	x	-	x	-	x	x	-	x	x	-	-	-	-	x	
2		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
3		x	x	x	x	x	-	x	-	-	x	-	x	x	x	x	x	x	x	-	x	x	-	-	-	-	
4		-	x	-	-	-	x	-	-	-	x	x	-	x	-	x	-	x	-	-	-	-	-	x	-	-	
5		x	x	x	x	x	x	-	-	x	-	x	-	x	x	-	x	-	x	x	x	x	-	-	x	-	
6		-	x	-	-	-	x	x	-	-	x	x	-	x	-	x	-	-	-	-	-	-	-	x	x	-	
7		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
8		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
9		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
10		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
11		x	-	x	x	x	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
12		x	-	x	x	x	x	x	x	x	-	x	x	-	x	-	x	x	x	-	x	x	-	-	-	-	
13		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
14		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
15		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
16		-	x	x	-	-	-	-	x	-	-	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	
TOTAL		13	13	13	13	13	13	12	12	12	12	12	12	12	12	12	12	12	11	11	11	11	11	10	9	9	
Percentage		81.3	81.3	81.3	81.3	81.3	75	75	75	75	75	75	75	75	75	75	75	68.8	68.8	68.8	68.8	68.8	62.5	56.3	56.3		