The Relationship among Active Learning of Students and Their Attitude towards Chemistry

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Abstract
The aim was to find out how students perceive teaching methods based on their active work. The sample included three classes from grammar school. Students completed a questionnaire on attitudes towards the subject and open questions on chemistry teaching. During one year the following were implemented: laboratory works, games, presentations, group work, experiments, chemical diary, worksheets and one excursion. Students perceived this style of teaching positively. It was reflected in their attitude to the subject.

Keywords: chemistry teaching; laboratory works; games; presentations; group work

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Introduction

What expectation does almost every child have about chemistry in primary school before his or her chemistry education starts? „It will be fun! There will be many hands-on activities and exciting experiments!" Children know about chemistry from funny videos, from open days of science or grammar schools. But to portray science such an unrealistic way can lead to disappointment with the reality of school chemistry (Abrahams, 2007). What can a teacher do to keep students interested in chemistry at a high level during elementary and also high school? As Reid says, interest in science develops early, by about the age of 14 and teachers have a very critical role in it, while things outside the school have almost no influence on it. „The greatest area of interest has been that of attitudes towards chemistry and physics" (Reid, 2011). In the Czech research of Kubiatko, there is a recommen-

dation that teachers can change negative attitudes towards chemistry focusing on everyday life, using chemical aids, methods of observation and experiments and inventing different types of learning activities (Kubiatko et al, 2016).

This study was aimed at finding out how students evaluate the chemistry subject if their teacher uses various elements of active learning. What do students propose to do in lessons after their first-year experience of chemistry at an eight-year grammar school and after their first year of high school? As Hidi & Harackiewitz (2000) proclaim, we need to get children engaged in activities and exposed to ideas and a variety of subject materials. And then they may become personally interested and develop mastery goals. The authors of this paper wanted to know whether one year of active learning with positive feedback of the teacher can influence the attitude of students towards chemistry. They used the autodiagnostic method according to the „implicit theory of good teaching of the subject from the view of difficulty, popularity and importance" and the „implicit theory of a successful student" (Hrabal & Pavelková, 2010).

Methodology

Research Sample

The study was done in one eight-year grammar school in Prague. There were 74 students in the sample, two classes (N = 27 + 25) from the 8th year (13 years old, first year with chemistry subject) and one class (N = 22) from the 11th year (16 years old, first year with high school chemistry). Students got a questionnaire about attitudes towards the chemistry subject with seven statements and four open questions about a current year of chemistry teaching at the end of the year with chemistry subject.

2.2 Questionnaire

The "Questionnaire Attitudes to Subjects I + II for Elementary and High School Students" was used, as described in Hrabal, Pavelková (2010, pp. 183 - 190). Version E is designed for students, F is designed for teachers. There are 7 statements with 5 possible answers according to the Likert scale. Students fill in the questionnaire and the teacher tries to guess about each student which answers he or she chose. Afterwards, a comparison between students and the guesses of their teacher is made. In the next step, the comparison between the mean of students' answers and the reference Table (based on 25 – 34 different secondary and high school classes) is made and also between the mean of teachers' answers and reference Table.

Statements

1. Popularity of Chemistry Subject (1 = very popular, 5 = very unpopular)
2. Difficulty of Chemistry Subject (1 = very difficult, 5 = very easy)
3. Importance of Chemistry Subject (1 = very important, 5 = not important at all)
4. Talent of Student for the Subject (1 = very talented, 5 = not talented at all)

5. Motivation of Student in the Subject (1 = very motivated, 5 = unmotivated)
6. Diligence of Student in the Subject (1 = very diligent, 5 = not working at all)
7. Performance of Student in the Subject (1 = very good, 5 = very bad performance)

Open questions

1. Was there too much of something in chemistry this year?
2. Was there a limited amount of time for something in chemistry this year?
3. What do you enjoy the most in chemistry this year?
4. What else would you like to see in chemistry subject?

2.3 Analysis

The questionnaire was analysed by SPSS software version 25 for descriptive statistic and paired T-test (the pair = student's answer + teacher's answer) at a 95% confidence interval of the difference. Open questions were analysed by the grounded theory (the coding of students´ answers, given similar answers into one category, choosing one central category and looking for its connections to other categories) according to Strauss & Corbin (1999).

Results and discussion

As it is shown in Table 1 and Table 2, the teacher from the monitored school was more optimistic about attitudes to chemistry and also about the abilities of her students then the students themselves. In statement 1 (Popularity of Chemistry), she guessed 30 times (41 %) correctly the answer of her students, 35 % of her students see chemistry subject as less popular than her and 24 % of her students like chemistry more than the teacher expected. In statement 2 (Difficulty of Chemistry) the teacher guessed 26 times (35 %) correctly the answer of her students, 48 % of them see chemistry as less difficult than she thinks and 17 % more difficult. In statement 3 (Importance of Chemistry), the teacher wrote 21 times (28 %) the same answer as her students, 35 % of them see chemistry as less important than their teacher thinks, 25 % more important. In statement 4 (Talent of Student), the teacher gave the same answer as her students just in 11 times (15 %), 70 % of her students are convinced that they are less talented than their teacher expects and 4 % evaluated themselves as more talented. The authors of the research are not surprised by this result because „bad self-image" is widely spread among students of especially difficult schools. In statement 5 (Motivation of Students), the answer of the teacher with her students coincided 15 times (20 %), 55 % of them wrote that they are less motivated than she expected and 24 % wrote that they are more motivated. In statement 6 (Diligence of Students), 13 times (17 %) the answer of the teacher was the same as her students' and 59 % of students were convinced that they were less diligent than their teacher expected. In statement 7 (Performance of Students), 34 times (46 %) the teacher guessed correctly the answer of her students, 43 % of them saw themselves as better performers, 10 % as worse performers. This statement was not very objective because the teacher evaluated students' performance but the students wrote their marks and that can be slightly

different, especially in the first year of chemistry. The teacher did not want to demotivate students because of their poor results from the chemistry subject.

Tab.1 Descriptive Statistics (Teacher=F, Student=E) source: Chlebounová, 2019

	F1	E1	F2	E2	F3	E3	F4	E4
N	74	74	74	74	74	74	74	73
Mean	2.59	2.69	2.50	2.93	2.28	2.65	2.08	3.34
Median	2.00	3.00	2.00	3.00	2.00	2.50	2.00	3.00
Mode	2	3	2	3	1	2	1	3
Std. Deviation	1.238	0.843	1.113	0.849	1.288	0.943	1.057	0.989
Minimum	1	1	1	1	1	1	1	1
Maximum	5	4	5	5	5	5	5	5
Percentiles 25	2.00	2.00	2.00	2.00	1.00	2.00	1.00	3.00
Percentiles 50	2.00	3.00	2.00	3.00	2.00	2.50	2.00	3.00
Percentiles 75	3.00	3.00	3.00	3.00	3.00	3.00	3.00	4.00

Tab.2 Descriptive Statistics (Teacher=F, Student=E) source: Chlebounová, 2019

	F5	E5	F6	E6	F7	E7
N	74	74	74	74	74	71
Mean	2.49	2.96	2.39	3.04	2.27	1.61
Median	2.00	3.00	2.00	3.00	2.00	2.00
Mode	2	3	1	3	1	1
Std. Deviation	1.306	0.999	1.353	0.943	1.417	0.665
Minimum	1	1	1	1	1	1
Maximum	5	5	5	5	5	5
Percentiles 25	1.75	2.00	1.00	2.00	1.00	1.00
Percentiles 50	2.00	3.00	2.00	3.00	2.00	2.00
Percentiles 75	3.00	4.00	3.25	4.00	3.00	2.00

In Table 3, a significant difference ($p < 0.05$) is shown between the evaluation of the teacher and the self-evaluation of her students through paired T-test. Only in statement 1 (Popularity of Chemistry) is there no significant difference.

Tab.3 Paired T-test (Teacher=F, Student=E), source: Chlebounová, 2019

Pair	N	Mean	Std. Deviation	Std. Error Mean	Sig. (2- tailed)
E1 – F1	74	0.095	1.252	0.145	0.518
E2 – F2	74	0.432	1.061	0.123	0.001
E3 – F3	74	0.365	1.504	0.175	0.040
E4 – F4	73	1.247	1.038	0.121	0.000
E5 – F5	74	0.473	1.455	0.169	0.007
E6 – F6	74	0.649	1.438	0.167	0.000
E7 – F7	71	0.648	1.160	0.138	0.000

Table 4 describes the comparison of the collected data with the Reference Table (Hrabal, Pavelková, 2010, p. 233). The interesting finding is that both groups, the teacher and her students, evaluated all 7 items more positive than the Reference Table, which is based on answers from 25 – 34 different classes. There could be a parallel here with Freedman (1997) according to whom „the laboratory influences student attitudes toward science and their achievement in science knowledge". During the last year, these students worked actively 5 times in the laboratory.

It seems also that a positive thinking of the teacher about her students and their abilities can lead students to a more positive way of thinking about themselves as well as chemistry. Of course, this statement would need to be proved on a bigger sample of students and teachers.

Tab.4 Comparison of Guesses of the Teacher (F), Answers of Students (E) and Reference Table (RT), which Was Done on at Least 25 Classes, source: Chlebounová, 2019

Statement	F Mean	RT F (Teachers) mean	E Mean	RT E (Students) Mean
1 Popularity	2.59	3.0	2.69	3.3
2 Difficulty	2.50	2.6	2.93	2.4
3 Importance	2.28	3.0	2.65	3.4
4 Talent	2.10	2.7	3.34	3.4
5 Motivation	2.49	3.0	2.96	3.4
6 Diligence	2.39	2.8	3.04	3.2
7 Performance	2.25	2.7	1.61	2.5

Reid says that ‘‘attitudes tend to be consistent and stable with the time but despite this stability they are open to some change and development’’ (Reid, 2011, p.7). There is a chance that the teacher can slightly change the attitude of the students towards chemistry subject by supporting activities to which students respond positively. The authors of this paper have the same experience with the results of their research.

Abrahams warned against attracting admitted students to interesting chemistry experiments during Open Days of the school (Abrahams, 2007, p. 2). He said that this picture of chemistry education is unrealistic and that it could undermine students’ satisfaction with the subject. This problem occurred in the collected data as well. Students had high expectations for chemistry subject from Open Days of the school. Although they have spent a lot of time by many different elements of active learning, including experiments, presenting papers, doing chemistry reading diary, projects in surroundings and inquiry based learning, they are still not satisfied and want to do them more often.

As Kubiatko et al (2017) saw that experimenting, the use of aids and information for life are connected with positive attitudes towards chemistry, the same is shown by this research.

Figure 1 shows the result of the 4 open questions which were processed by the Grounded Theory. From the first coding, the following topics were described as popular: Separating methods, Water, Elements, Lessons to Life (younger students), Carbohydrates, Fats, Proteins, Radioactivity + Atom, Macromolecules, Spectrophotometry, Lessons to Life (older students). Students reflected upon active learning positively and 17 of them said that nothing needs to be changed. Some of them mentioned that experiments need more time for deeper analysis, laboratory work could be more „professional’’ and it would be fine to do more measuring in the surroundings. Some of them gave tips for clearer evaluation of the teacher – checking more strictly that nobody is copying, write the test score on time and so on. Most students enjoyed active learning and want more opportunities to do it. In Figure 1, there is Improvement of Teaching as the Central Category and tips of students are grouped into 7 other Categories.

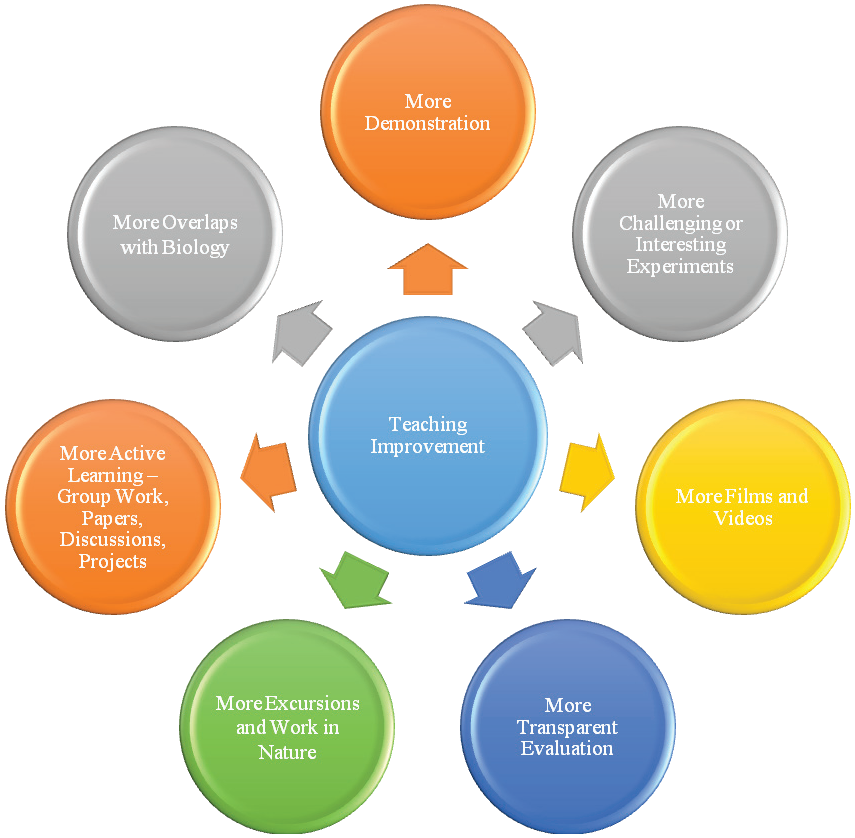

Fig. 1 Grounded Theory – Dependence of the Central Category "Teaching Improvement" on the Other Categories, source: Chlebounová 2019

Conclusion

The self-diagnostics of the teacher shows that she is more optimistic in her evaluation of her students than her students are towards themselves. Her positive feedback probably had positive effect on the students because their self-evaluation was more optimistic than is common among students from other schools according to the Reference Table. It would be good to know whether it is true that "the better impression about his or her students a teacher has, the better their attitude towards his/her subject is".

Most students like active learning and want to do it more often (especially laboratory work). The improvement of teaching proposed by the students is based on the implementation of active learning (group work, papers, discussions, projects, excursions and work in surroundings, interesting and challenging experiments) to a high extent. Students have experienced laboratory work 5 times in the current year. They appreciate it but want more opportunities for laboratory work than they

have had this year. The results support the idea that active cooperative learning accompanied by the positive feedback of the teacher leads to a better attitude of students towards the subject.

The weak point of this research is the small sample size. The authors would like to use the results of the teachers´ self-diagnostics in grouping of students for the next part of their qualitative study.

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