

Pedagogical Research Methodology in Would-Be Biology Teachers' Theses

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Abstract

As we want the students to be able to analyze and work with information, it is necessary to enhance such competence of the potential teachers in particular. The "teacher as researcher" is becoming synonymous with the "teacher as professional", who keeps track in self-development and is involved in research. Therefore, we have conducted a content analysis to find out the methodology level of would-be biology teachers theses, because we believe such an analysis is one of the possible ways of gaining an idea about the success of future teachers' preparation. We analyzed all theses (n = 199) defended at both departments that prepare biology teachers in Prague, Czech Republic in years 2014-2016. We identified 80 main or supplementary pieces of research, mainly quantitative (77%), the most frequently used tool for acquiring data was a questionnaire (61%). Although many of these researches were methodologically acceptable, we found a large number of fundamental methodological misconduct – 41% cases does not specify the method of sampling, 90% questionnaire based researches use newly constructed research tool and 61% of them were done without pilot tool validation; 62% of researches presented data without even basic statistical processing. There was a significant difference between two faculties in methodological practice we believe to be caused by including a specialized course in study plan. A further research on building would-be teachers pedagogical research methodology knowledge is needed to investigate how to best fulfill an idea of "teacher as professional".

Keywords: *would-be teacher education, biology, thesis, research methodology, pedagogical research*

1. Introduction

As teachers and student trainers, we have felt the need to reflect on our students' ability to master the teaching research methodology [1]. If pedagogy is to dispose of its cargo-cult [2] science label and work on the basis of an evidence-based approach, future teachers must be well educated in the methodology of pedagogical research [3], [4]. As a way to explore the state of understanding and mastery of this issue by master students, we chose to analyze the final theses [5]. The final thesis is an individual work of a student, it should meet the criteria of scientific work and, according to our claim, it represents one of possible sources for describing the achieved state of their education.

2. Methods

In the area of our interest, Central Bohemia, there are two departments dealing with the preparation of future biology teachers, Faculty of Education (FoE) and Faculty of Science (FoS) at Charles University. We have included in our analysis final theses defended in 2014-2016 from both departments. We have only studied the theses submitted to the Biological Committee, ie those dealing either directly with biological topics and their didactic aspects. In total, 199 final theses were analyzed within which we distinguished 80 pedagogical research whose methodological characteristics we followed. Discarded 119 papers were either reviews or dedicated to biological research that cannot be compared with pedagogically oriented research.

In this study, we examined the *type of research*, the *research tool*, the way of *communicating with the respondents*, the methods of *selecting the respondents* and the method of *statistical data processing*. Using Fisher's exact test we compared the representation of selected categories between the two departments. Differences were considered significant if the test level reached (p) was less than the selected 5% significance level. The statistical package R version 3.1.1 was used for the calculation [6].

3. Results

Of the total number of analyzed educational researches, 18 (23%) were qualitatively focused and 62 (77%) were quantitative. Some of the monitored categories were occasionally not applicable to the



given work (statistical processing of qualitative research or the way of communication in textbook analyzes) therefore, relative frequencies calculated from different bases (equal to or less than 80 surveys) are given below.

When analyzing the *research tool*, the questionnaire (49, 61%) dominated, as shown in Table 1. No difference was found between the departments ($p = 0.66$).

Table 1: Usage of research tools results.

	$\Sigma = 80$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Questionnaire		49	61,25 %	36	13
Interview		9	11,25 %	7	2
Didactic test		8	10,00 %	5	3
Textbook analysis		7	8,75 %	7	0
Observation		6	7,50 %	5	1
Other		1	1,25 %	1	0

In terms of originality, the vast majority (60, 90%) of the research was based on *de novo* created research tools, and only minority took over or modified (7, 10%) the already existing tool, as summarized in Table 2, departments did not show any difference ($p = 0.09$).

Table 2: Originality of research tools results

	$\Sigma = 67$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
New		60	89.55 %	45	15
Modified/taken as is		7	10.45 %	3	4

Questionnaires ($n = 49$) were in most cases not pilot tested before use (33, 67%), again only a minor part was piloted (16, 33%), for overall results across different tools see Table 3. There were significant differences between our departments ($p < 0.001$); Only in one work the reliability of the research tool was mentioned and reliability, namely the Cronbach alpha value, was calculated. None of the other 48 authors dealt with the reliability of the tool used. In the context of the questionnaire used, none of the researches mention validity.

Table 3: Pilot validation of used tools results.

	$\Sigma = 57$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Pilot study		22	38.60 %	8	14
No pilot study		35	61.40 %	33	2

In the category *communicating with the respondents* we distinguish an electronic form (on-line questionnaire) and questionnaire send by an email as a separate categories, shown in Table 4. When merging these categories, it can be said that 50 (69%) of researches were only submitted in person and 14 (20%) were only submitted electronically. If graduates chose an electronic form, they sent the questionnaire either by e-mail or by using an on-line questionnaire. There was no difference between the departments ($p = 0.78$).



Table 4: Ways of communication with the respondents results.

	$\Sigma = 72$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Personally		50	69,44 %	35	15
Electronic form		10	13,89 %	7	3
Combination personally + electronically		7	9,72 %	6	1
Email		4	5,56 %	4	0
Not specified		1	1,39 %	1	0

li	$\Sigma = 72$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Personally		50	69,44 %	35	15
Electronic form		10	13,89 %	7	3

Table 5: Who was collecting data results.

	$\Sigma = 70$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Graduate		56	80,00 %	39	17
Not specified		7	10,00 %	6	1
Graduate + teacher combination		4	5,71 %	3	1
Teacher		3	4,29 %	3	0

We were interested in how the graduates *selected the respondents*, and in particular whether they were aware of the significance of this information (and therefore did not forget to mention it). The different types of selection are shown in Table 6, but it cannot be stressed that 31 graduates (41%) did not state at all how the selection was made ($n = 75$). There was a significant difference between the faculties ($p < 0.01$), the description of the selection was more often presented at FoS.

Table 6: Methods of respondents selection results.

	$\Sigma = 75$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Not specified		31	41,33 %	26	5
Home school, school working, etc.		13	17,33 %	8	5
Mikroregion		12	16,00 %	10	2
Targeted selection		7	9,33 %	7	0
Whole file		6	8,00 %	3	3
Classmates (ie other graduates)		4	5,33 %	0	4
Snowball		2	2,67 %	2	0

The last monitored category describes the rate of *statistical data processing* of the quantitative data obtained and was applied only to works where the nature of the research allowed the formulation of hypotheses and their testing. Most of the analyzed works were limited to the indication of absolute and relative frequencies (38, 62%), few works (2, 3%) used descriptive statistics and (21, 34 %) used inductive statistics; the results are summarized in Table 7 ($n = 61$). There was a significant difference ($p < 0.001$) in terms of higher use of statistical methods at FoS.



Table 7: Statistical data processing of quantitative data results.

	$\Sigma = 61$	Absolute frequency	Relative frequency	Absolute frequency FoE	Absolute frequency FoS
Only absolute and relative frequencies		38	62,30 %	36	2
Inductive statistics		21	34,43 %	7	14
Only descriptive statistics		2	3,28 %	2	0

4. Discussion

Looking at the results of the analysis, it can be stated that a) the level of knowledge and skills acquired in the field of pedagogical research is unsatisfactory b) that there is a significant difference between departments where the students graduated. The questionnaire was newly created in most cases, and the research did not include a pilot survey. The validity of the questionnaire was not verified by any of the graduates, only one verified the reliability.

Similarly, it is worrying that in more than 40% of researches there is no information about selecting respondents, suggesting that not graduates and probably neither their trainers consider this information essential. We even encountered misleading formulations like: "*cities [of which respondents came from] were chosen ... according to my options, that is, randomly*", from which it is clear that a graduate definitely did not understand what a random selection is.

As a last factor, we evaluated the statistical data processing rate. In two-thirds of the analyzed studies, the graduates' outputs were limited to frequencies, which probably did not allow students to gain a deeper insight into the issues they examined, or to formulate the right answers to their research questions. In 34% of the investigations, hypotheses were tested using inductive statistics. The rate of use of inductive statistics varied between departments in favor of FoS.

This is also demonstrated by our finding that FoS graduates manifest a significantly higher rate of methodological knowledge. This is perhaps [7], [8] related to the subject of the Research Method in Science Education, which is offered to students of all combinations of teaching (ie biology, but also chemistry, geography and geology) at FoS. In this course, students are acquainted with basic methods of pedagogical research, possibilities and assumptions of their use. There is no similar course at FoE currently offered, which may be reflected in the methodology of the theses.

The results of our study revealed some education gap. These include in particular: insufficient ability of description and justification of the choice of research methods and tools used, lack of psychometric properties verification in used research tools, insufficient description of the respondents' selection and justification of the choice of data processing methods. Based on the data we would like to emphasize the need to purposefully cultivation of methodology skills of would-be teachers. The introduction of methodological subjects focusing on pedagogical research (and motivating students to choose them if they are already on offer) and a more consistent approach of trainers and opponents of theses could be a partial solution.

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