Abstract

This article contains results of studies and comparisons of conceptual competence in didactics demonstrated by 115 students – future and currently practicing teachers. The article gives an insight into conceptual competence in didactics in terms of strength of mastering the didactic knowledge, structuring this knowledge when solving didactic problems and the ability to freely operate didactic concepts when stating new problems associated with learning process organization and assessment of its results. The article describes the study procedure based on analysis of definitions of didactic concepts (a total of 3487 definitions were processed), 353 concept maps, as well as statements of problems in the educational field (a total of 400 statements were analyzed). The level of conceptual competence in didactics possessed by Russian students and teachers with different educational specialization (primary school, humanitarian sciences, natural sciences, supplementary education) is identified and assessed based on the developed assessment criteria, and the nature of relationship between the level of demonstration of such competence and sources and means of renewing and acquiring didactic information when encountering difficulties.

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1. Introduction

The problem of studying and developing didactic competence during training of teachers for independent professional activity has even more important in Russian educational practice, mainly due to the world-wide trend of competency-based approach to education and evaluation of teachers as professionals (Zimnyaya I.A., 2004; Borko H., Whitcomb A., 2008; Sharonova S.A., 2008; Hutorskoy A.V., 2013).

However, it should be noted that Russian scientists and practicing educators are still focused on issues associated with theoretical preparedness of a teacher to organize the learning process, due to introduction of a professional standard for teachers ("Pedagog"). This standard formulates requirements for proficiency with didactic terminology to be applied when designing an educational program and conducting educational activities.
Didactic terms are used in professional communication of teachers as a means of maintaining and replenishing didactic knowledge that is updated with the progress of theory and practice (Leychik V.M., 2007). Meanwhile, a teacher often experiences problems of proficiency with didactic concepts in learning situations, when formulating new problems, explaining complicated cases or analyzing unexpected results of education, presenting arguments for an educational innovation or developing new conditions for their classes. This is why development of conceptual competence in didactics can be considered one of the indicators of a teacher’s readiness not only to analyze didactic situations and to search for new efficient ways of resolving them, but rather to state new problems and to model new experiences. Didactic terminology operation depends on many external and internal factors, predominantly on the quality of pedagogical training (Bordovskai a N.V., 2002) and underlying psychological mechanisms, teacher’s mental experience (Holodnaya M.A., 2002).

In their search for efficient methods of improving the quality of education and its results, teachers not only become familiar with new scientific achievements, but also strive to actively use these achievements in their practice. In order to increase the level of mastering and adequate use of achievements in the field of didactics, one should be able to identify and consider particular characteristics of already-formed conceptual and terminological structure, and factors that affect its renewal both at the training stage and during independent practice of teachers. A question follows: Are conceptual and terminological structures of future teachers different from those of practicing teachers when it comes to solving didactic problems, and which factors affect the process of operating the didactic terms?

**Purpose of the Study.** The purpose of this study is to characterize conceptual and terminological structures of future and practicing teachers based on the following parameters:

- identification of positions when interpreting the scope and contents of didactic terms being applied;
- identification of the structure of principal conceptual and terminological fields when solving didactic problems;
- operation of didactic concepts when formulating problems associated with educational process organization and assessments of results, and when searching for methods of resolving such problems.

**The Concept.** Conceptual competence in didactics of a teacher is the ability to explain specifics of a learning practice or model, to describe teaching innovations, or to model a new teaching practice based on efficient use and application of didactic terms. In order to promote objectivity in assessment of the dynamics of development of conceptual competence in didactics of future and practicing teachers, this integral framework is viewed as a comprehensive structure in three aspects that correspond to the three principal components:

- strength of retention of didactic knowledge;
- structuring of this knowledge when solving didactic problems;
- fluent operation of didactic concepts when formulating new problems associated with organization of learning process and assessment of results.

2. **Design and Research Methods**

**Participants.** The study involved 115 students of the Lomonosov Northern (Arctic) Federal University (Arkhangelsk, Russia), 18 to 30 years of age, with 17 male students and 98 female students (15% and 85% respectively), and 115 practicing teachers of general education schools in Arkhangelsk region, 20 to 65 years of age, among them 5 male teachers and 110 female teachers (4% and 96% respectively). A total of 230 subjects took part in the study.

**Research Methods and Instruments.** The following methods were used in this study:

- questionnaire surveys used to identify and describe new social and professional characteristics of participants (students and teachers);
- contextual analysis used to interpret definitions of didactic terms with maximum accuracy;
- method of concept maps that implies identification of existing relationships between didactic concepts being used;
- adapted version of "Problem Formulation" procedure (Holodnaya M.A., 1983) used to determine comprehensiveness of individual conceptual and terminological structures;
- "Thinking Style" questionnaire (adapted from A.A. Alexeyev, L.A. Gromova, 1993) used for identification of preferred thinking styles;
content analysis, statistical methods (Spearman and Kendall correlation tests, Mann-Whitney test) used to process findings of the study.

Strength of knowledge was assessed based on the number of didactic concepts included in the concept and terminology map. Respondents who included at least 4 concepts in their map were attributed to the first level, those who used 5 to 8 concepts to the second level, those from 9 to 13 concepts to the third level, and those with 14 to 17 concepts to the fourth level.

The extent of development of conceptual competence in didactics was determined based on the concept map cognitive complexity assessment criteria proposed by Bogdanova E.L. and Bogdanova O.E. (2001). All concept maps were divided into 4 groups:

a) visual concept maps where pictures with certain emotionally loaded context are used to represent relationships between concepts (no linear relationships, or only one level of relationship is registered);

b) linear concept maps, where concepts are structured in horizontal or vertical chains without representation of the hierarchy between them (2 to 4 levels of relationships are registered);

c) concept tree maps, where multilevel hierarchy, generally vertical, of concepts is demonstrated (5 to 8 levels of relationships are registered);

d) complex concept maps, with multilevel organization (clearly defined center and periphery, multilevel horizontal and vertical links, use of graphic forms to demonstrate hierarchy of concepts with maximum accuracy) (more than 9 levels of relationships are registered).

Completeness of conceptual and terminological structure as characteristics of systematization of retained and applied didactic knowledge was determined through assessment of complexity of formulated didactic problems:

- low level, if a problem was formulated based on respondent's situational assessments or subjective reactions to educational process conditions at school;
- medium level, if a problem was formulated based on distinguishing certain signs or properties beyond solving situational problems that arise in the course of the teaching process;
- high level, if a problem was formulated through the use of a sufficient number of didactic terms while operating beyond substantive activity of a teacher or teachers' work with individual student and transitioning into the field of organization of the teaching process and shaping of educational environment.

The level of conceptual competence in didactics was determined based on complexity of conceptual schemes being built; the following criteria was selected for each level:

- low level of development was demonstrated by respondents who have elaborated at least one didactic category and at least 2 concepts that reflect specific nature of school teacher's activity;
- medium level was reserved for respondents who have elaborated at least 2 didactic categories, at least 4 concepts that reflect specific nature of school teacher's activity, and at least 3 concepts that capture results of the educational process;
- high level was attributed to respondents who have elaborated the contents of principal didactic categories (education, teaching, learning), at least 6 concepts that reflect specific nature of school teacher's activity, and at least 5 concepts that capture results of the educational process.

Procedure. In order to collect the data required, a special questionnaire, consisting of three sections, was developed. In the first section respondents were asked to indicate their personal information (sex, age, year of study or the number of years worked, academic performance or qualification level), sources of didactic information, as well as principal actions taken when searching for and modelling options to solve a didactic problem. The second section consisted of tasks where respondents were asked to elaborate on 17 didactic terms and to build concept maps based on those didactic terms so as to demonstrate understanding of existing relationships between given concepts. The third section was intended for respondents to complete psychological procedures and tests. Questionnaires were completed by attending respondents, on condition of anonymity.

3. Results

Objective 1. To identify predominant nature of relationship between conceptual competence in didactics as a whole and its parts as demonstrated by students and practicing teachers, as a system-forming factor of development
of competence.

As a result, the following statistically significant relationships were identified:

- between complexity of conceptual maps built and systematic nature of retained didactic knowledge applied by students and teachers when solving didactic problems (p<0.000);
- between the strength of retention of didactic terminology with which students and teachers were proficient and were able to define, and ability to consistently use this knowledge when making arguments for and explaining the logic behind their actions during solving of didactic problems (p≤0.005);
- between the strength of retention of didactic terminology with which students and teachers were proficient, and complexity of conceptual maps being built when resolving didactic situations (p≤0.000).

The relationships were identified using Spearman rank correlation test (reported) and confirmed by the Kendall rank correlation coefficient.

Results of the statistical analysis demonstrated that the level of the development of conceptual and didactic competency for teachers depends on the amount of concepts retained and on the ability to use them within certain logic, but does not depend on professional experience. Meanwhile, during professional training, development of conceptual competence in didactics depends greatly on subject's academic performance and strength of didactic terminology retention. This can be explained by the fact that knowledge of pedagogical terminology is usually a mandatory component of professional training of a teacher and one of the criteria of effectiveness of such training.

**Objective 2.** To identify possible influence of the period of training (for students) and years of work experience (for teachers) on the complexity of built concept maps as an indication of development of conceptual competence in didactics.

Statistically significant differences were indicated for teachers with work experience of less than 5 years and that between 16 and 20 years using the Mann-Whitney test (Table 1). Moreover, the level of complexity of concept maps is higher for the group of teachers with work experience of 16 to 20 years than that for teachers with less than 5 years’ work experience. It is fair to assume that relatively high level of development of conceptual competence in didactics of teachers with less than 5 years’ work experience is due to a short time elapsing after professional training, while for teachers with 16 to 20 years of experience it is associated with the peak of their career.

<table>
<thead>
<tr>
<th>Years of work experience</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Z</th>
<th>Asymp.Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 5 years</td>
<td>11.98</td>
<td>239.50</td>
<td>-3.276</td>
<td>0.001</td>
</tr>
<tr>
<td>16 to 20 years</td>
<td>22.55</td>
<td>225.50</td>
<td>-3.270</td>
<td>0.001</td>
</tr>
<tr>
<td>16 to 20 years</td>
<td>17.10</td>
<td>171.00</td>
<td>-3.270</td>
<td>0.001</td>
</tr>
<tr>
<td>31 to 35 years</td>
<td>8.08</td>
<td>105.00</td>
<td>-3.270</td>
<td>0.001</td>
</tr>
</tbody>
</table>

No statistically significant differences were identified between students in different years of training based on "concept map building complexity". Therefore this is not an essential attribute for assessing subjects' conceptual competence in didactics development level at the professional training stage.

**Objective 3.** In order to determine possible differences between conceptual and terminological competence development level depending on professional specialization, attribute "concept map building complexity" was compared between four groups of respondents based on their specialization: "primary school teacher", "supplementary education teacher", "teacher of natural sciences and mathematics", and "teacher of humanitarian sciences" using the Mann-Whitney test (Table 2).

The following significant differences were identified between groups of students based on their specialization:

- a) "primary school teacher" and "supplementary education teacher". The level of conceptual competence in didactics is higher for students with "supplementary education teacher" specialization;
- b) "primary school teacher" and "teacher of natural sciences and mathematics". The level of conceptual competence in didactics is higher for students with "teacher of natural sciences and mathematics" specialization;
- c) "teacher of humanitarian sciences" and "supplementary education teacher". The level of conceptual competence in didactics is higher for students with "teacher of humanitarian sciences" specialization.
- d) "primary school teacher" and "teacher of humanitarian sciences". The level of conceptual competence in didactics is higher for students with "teacher of humanitarian sciences" specialization.
Table 2. Statistically significant differences between specialization of students and complexity of built concept maps

<table>
<thead>
<tr>
<th>Specialization</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Z</th>
<th>Asymp.Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary school teacher</td>
<td>25.56</td>
<td>1048.00</td>
<td>-2.295</td>
<td>0.022</td>
</tr>
<tr>
<td>Supplementary education teacher</td>
<td>35.14</td>
<td>492.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary school teacher</td>
<td>27.76</td>
<td>1138.00</td>
<td>-3.138</td>
<td>0.002</td>
</tr>
<tr>
<td>Teacher of natural sciences and mathematics</td>
<td>40.96</td>
<td>942.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher of humanitarian sciences</td>
<td>28.06</td>
<td>982.00</td>
<td>-2.460</td>
<td>0.014</td>
</tr>
<tr>
<td>Supplementary education teacher</td>
<td>17.36</td>
<td>243.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary school teacher</td>
<td>27.60</td>
<td>1131.50</td>
<td>-4.989</td>
<td>0.000</td>
</tr>
<tr>
<td>Teacher of humanitarian sciences</td>
<td>51.27</td>
<td>1794.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Obtained results suggest that specialization does influence conceptual competence in didactics during training of teachers. Future primary school teachers tend to demonstrate low level of conceptual competence in didactics. The underlying reasons include low cultural level of respondents, insufficiently strict requirements imposed on students during learning of didactics, low academic performance, etc. The problem of low level of conceptual competence in didactics of future primary school teachers in Russia calls for further investigation.

No statistically significant differences were identified between concept map building complexity and specialization for practicing teachers. Therefore this attribute cannot be considered an essential one when assessing the level of subjects' conceptual competence in didactics development at the stage of professional activity.

**Objective 4.** To identify differences between conceptual competence in didactics development and preferred thinking style of future and practicing teachers.

According to A.A. Alexeyev and L.A. Gromova (1993), thinking style is a system of intellectual strategies, devices, skills and operations to which a person is inclined due to their individual personality traits (from person's set of values and motivation to traits of character). These authors, who followed the lead of A.F. Harrison and R.M. Bramson (Harrison A.F., Bramson R.M., 1984), identified five thinking styles: analyst, synthesist, realist, pragmatist, and idealist. Each of these styles determines specific approaches to problem solving, individual methods of perception and processing of information, criteria and methods of decision making, etc.

Comparing levels of conceptual and didactic development based on "thinking style" attribute allowed to identify significant differences for teachers with idealistic thinking style (Table 3) and for students with realistic thinking style (Table 4) - as a tendency.

Table 3. Differences between levels of conceptual competence in didactics development of teachers with idealistic thinking style ("Thinking Style" questionnaire)

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
<th>Z</th>
<th>Asymp.Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>36.83</td>
<td>1768.00</td>
<td>-1.895</td>
<td>0.058</td>
</tr>
<tr>
<td>High</td>
<td>26.84</td>
<td>510.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>27.45</td>
<td>796.00</td>
<td>-1.807</td>
<td>0.071</td>
</tr>
<tr>
<td>High</td>
<td>20.00</td>
<td>380.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Obtained results suggest the following: the higher teacher's conceptual competence in didactics development level, the lower is the probability of this teacher having idealistic thinking style. This can be due to the fact that teachers who prefer idealistic thinking style are prone to intuitive, global assessments without resorting to detailed analysis of didactic problems based on facts and formal logic, and focus more on goals, needs, values and ethical problems in teaching. They are successful in solving those didactic problems where emotions, feelings, and evaluations are important factors. Teachers with idealistic thinking style experience difficulties with didactic problems that are well formulated, structured and can be expressed in mathematical or logical terms, and need to be solved using algorithmic procedures (Alexeyev A.A., Gromova L.A., 1993, pp. 19-20).
According to the Table 4 students with realistic thinking style demonstrate higher conceptual competence in didactics development level. These students are solely fact-oriented when describing or explaining didactic problems; they consider something "real" only when they can personally feel, see or hear it. Students with this thinking style are precise in selection of didactic concepts and focus on amending and correcting when working with concept maps in order to achieve the best possible result. Orientation of students towards top results in learning and practical work with concept maps improves their conceptual competence in didactics when realistic thinking style is predominant.

Objective 5. Influence of respondents' preferences in selection of sources of scientific and practical information and their actions with unfamiliar pedagogical terminology (situation of difficulty) encountered in textual sources on operation of didactic terms was analyzed. Data obtained from such analysis was essential for receiving objective information regarding specific aspects of development of conceptual competence in didactics by students and practicing teachers.

Statistical analysis of empirical data (Mann-Whitney test) allowed to identify the following differences between levels of conceptual competence in didactics development based on "source of information" and "preferred actions with unfamiliar terms" attributes:

a) difference between low and high level of conceptual competence in didactics development of teachers and using communication with colleagues as the preferred method of obtaining scientific and practical information (p≤0.04).

b) difference between low and high level of conceptual competence in didactics development of teachers and consulting colleagues when encountering difficulties with understanding of an unfamiliar term (p≤0.034).

c) for students, the following tendency was identified: students with lower level of conceptual competence in didactics development tend to use books and educational aids as the main source of scientific and practical information (p≤0.075). Students with higher level of conceptual competence in didactics development more often resort to the text of the source when having difficulties understanding an unfamiliar term (p≤0.078).

These data indicate that communicative function of a didactic term that allows to communicate and acquire professionally important information with maximum accuracy is the most valued by teachers when operating didactic terminology. Students' level of conceptual and didactic terminology development and its demonstration is determined by traditional ways of Russian professional training organization. Professional pedagogical knowledge is obtained on the basic level from specialized educational literature on pedagogy. More fundamental training involves use of scientific sources understanding of which depends directly on how accurately both the author and readers interpret concepts used in these sources.

4. Discussion

Both foreign and Russian publications dedicated to the problem of operating pedagogical terminology during professional training in pedagogy and in the course of independent teaching activity, allowed to make the following observations. On methodological level, there are very few approaches to assessment of the role of didactic terminology in professional activity of a teacher. On one hand, concepts linked within a system act as main elements of knowledge (Novak J.D., 1998). Therefore, teaching process can be considered a conscious assimilation, incorporation of new knowledge and new concepts into an already existing conceptual framework (Vygotsky L.S., 1982; Ausubel D.P., Novak J.D., & Hanesian H., 1978). Thus, with regard to mastering didactic terminology, the training phase should be viewed as the stage when conceptual competence in didactics is shaped which will help
improve the quality of interpretation when analyzing and describing a teaching model or practice, teaching innovations or when modeling a new teaching practice in future.

Our study, that was intended to identify features that are common and unique to operating didactic concepts during professional training phase and in the course of professional activity, confirmed conclusions made by M.A. Holodnaya (Holodnaya M.A., 1983) that indicators of changes of conceptual structure may include the ability to define a concept and to build generalizations.

Nature of concept structures and the degree to which they are formed vary individually. However, we found common attributes that allow to identify specific characteristics of how conceptual competence in didactics is being formed and implemented: better understanding and retention of concepts makes it easier for a subject to identify complex and multilevel links and relationships between these concepts and to use them when making arguments and explaining the logic behind their actions when solving didactic problems. Individual specific features of how conceptual competence in didactics is demonstrated depend on the context in which the given concept was retained, the experience of operating this concept during training and professional activity, as well as individual thinking patterns.

5. Conclusions

Results of the study allowed to identify a complex of internal and external factors that influence development and demonstration of conceptual competence in didactics during professional training and in the course of independent teaching activity. External factors include professional specialization in the course of teacher's education process, the training period, and duration of professional experience as a teacher. Internal factors include predominance of a certain thinking style, as well as individual preferences in selection of sources of scientific and practical information, and actions taken in case of difficulties encountered when solving didactic problems and difficulties with understanding a new term.

Results of the study allowed to conclude that both students and teachers are not sufficiently proficient in building logic schemes, which in turn makes them less capable of systematizing theoretical and practical knowledge of educational process organization in the most accurate manner, as well as of identifying the position of a separate didactic term within conceptual and didactic framework of pedagogy.

References