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Application of ICT-based Learning Resources for University Inorganic Chemistry Course Training

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Abstract. The article studies expediency and efficiency of various ICT-based learning resources use in university inorganic chemistry course training, detects difference of attitudes toward electronic resources between students and faculty members, which create the background for their efficiency loss.

Keywords: ICT-based learning resources; inorganic chemistry training; learning styles.

Introduction. Appropriate, well-balanced and efficient selection of electronic learning resources based on the information and communications technology (ICT) is an important stage of novel electronic technologies introduction into traditional training systems. The selected learning resources should match the content of curriculum and be easy for the students to understand. The term “ICT-based learning resource” (or in abbreviated form ICT-LR) includes the following aspects of the concept: a digital form of data registration, processing and presentation; computer hardware and software for simulation, planning and control; and electronic environment for communication including networks and communication facilities.

Nowadays, the use of electronic resources in science education enhances and supports the learning process because a person can acquire new knowledge in a more flexible and adaptable way if compared to the traditional method. However, available ICT-based resources are under-explored with relation to the completeness of the university chemistry curriculum coverage.

There is a long-term debate, concerning the relationship between teaching and learning styles and their impact on students’ performance [1]. A general problem of teaching-learning mismatching is partly concerned with possible differences in the attitude toward the ICT-LRs used between the two parties involved in the learning process. An essential difference between learning styles of students and teachers is often observed [2, 3]. Since a teaching style is a combination of teaching methods and techniques that a lecturer/teacher prefers in his/her teaching, the above difference can promote the difference in attitudes toward the resources used. As that matching may affect learning efficiency, this article focuses on the level of match/mismatch in students’ and lecturers’ attitudes toward information resources within basic chemistry disciplines, an area not previously researched in respect of these characteristics.

The main objective of this research was to determine the real potential for practical use of various ICT-LRs in the university course of inorganic chemistry training and estimate the students’ and instructors’ attitudes toward these resources. The following issues were considered more thoroughly:

- What ICT-LRs best suit inorganic chemistry training from the viewpoints of both students and faculty members?
- Do the students’ preferences in ICT-LRs match the instructors’ choice?

Methods. The research was performed at the Faculty of Chemistry of Dnepropetrovsk National University (DNU) in Ukraine. Frequency and expediency of the use of a number of electronic resources in teaching of inorganic chemistry course was studied. Total 5 faculty

members, used to inorganic chemistry teaching and 46 graduate students, who already took the inorganic chemistry course during their undergraduate studies, have participated in the survey.

The survey is focused on the evaluation of both students and teachers' attitude toward ICT-based resources used for inorganic chemistry training. Preliminary studies allowed the author to determine 45 resources which either can be used or are already used at the Faculty of Chemistry. Special questionnaires, which include all tentatively identified resources, were developed to cover the course content. The course was divided into 24 units in correspondence with the actual curriculum. All interviewees were asked to evaluate their attitudes toward the implementation of a particular resource in teaching of each unit from the viewpoints of necessity and rationality. The used score system and related criteria are shown in Table. Lack of response was considered as either impossibility or unwillingness of a respondent to define his/her attitude toward a particular resource. Blank fields were not taken into account during data processing.

Table

Score system used in questionnaires

Score	Criteria
0	The use of this resource is unnecessary
1	The use of this resource facilitates digestion of chemistry knowledge. However, it has no essential advantages over other similar resources
2	This resource is highly recommended and readily used because its use provides additional benefits compared to other similar resources

There was a certain difference between students' and faculties' questionnaires. The main goal of students' survey was to investigate personal attitudes toward all individual resources. The faculties were asked two questions. The first one was similar to that in students' questionnaires. The second question was to mark only those resources which are actually used by an interviewee. The individual results of faculty members were statistically processed to assess the agreement level among the participated experts. The processed figures of faculties' questionnaires allowed the author to fix the current situation, concerning implementation of particular ICT-LRs in inorganic chemistry training, select most relevant resources for further analysis and evaluate their necessity in practical work. For each resource, the scores from the completed questionnaires were first averaged over all units to calculate the mean scores for each participant. Then the values of students' or faculties' resource average scores, denoted hereinafter as RASs, were calculated for each considered resource.

The primary statistical procedures used in this study were descriptive statistics, Pearson's correlation analysis and Kendall's non-parametric tests for rank variables. The significance level of 0.05 was used in all hypothesis tests.

Results and Discussion. The results of survey allowed the author to collect detailed information, concerning students' and faculties' attitudes toward individual resources used in inorganic chemistry training. Certain mismatching between students and faculties' opinions is evident from the results obtained.

The practical value of particular resources was assessed on the basis of faculties' responses. Agreement among experts was estimated by calculation of Kendall's coefficient of concordance W. The value $W=0.837$ was obtained evidencing a very high level ($p<0.001$) of unanimity among the experts' opinions. Therefore, the results of survey fairly and objectively represent the current state-of-the-art of electronic resources implementation in inorganic chemistry training at DNU.

A resource average score, RAS, by the faculties' questionnaires was considered as a main indicator of its relevance. Based on the results of individual questionnaires, a sample histogram was plotted in coordinates "number of resources versus RAS". The resultant curve exhibits bimodal behaviour with two peaks at RAS=0.4 and RAS=1.1 and a relative boarder between them at RAS=0.75. Both peaks obey the normal distribution.

There exist two modes which correspond to relatively unclaimed and highly relevant resources respectively. In accordance with the observed bimodal distribution, all ICT-LRs are divided into two groups. The first one contains the most relevant resources with the average RAS=1.1 which are nominated as universal. Resources with low scores compose the second group.

Part of such resources stably takes low scores for all units that cause a low RAS for the discipline as a whole. Therefore such resources are inherently universal but of a low priority. Other resources of the second group are characterized by highly volatile scores. Their low RAS is formed by a combination of almost zero scores for some units and rather high scores for other units. Therefore, such resources are valuable for teaching of some themes of inorganic chemistry but are unnecessary for the others. They can be nominated as specific resources because are meant for a limited number of units.

Non-zero scores were recorded for 37 resources among 45 ICT-LRs listed in the questionnaires. The analysis of score distributions with respect to individual course units allows one to identify 33 resources of universal type and 4 specific resources. The values of RAS for 20 universal resources exceed the threshold RAS=0.75 so that all they are important means for inorganic chemistry training. The rest of universal resources with an average RAS~0.4 have a rather low practical value. In contrast to the optimal kit, only 10 universal and 4 specific resources have been already introduced into the inorganic chemistry training at the Faculty of Chemistry of DNU.

The map, illustrating relationships between students and faculties' scores is shown in Fig. 1. Close values of RASs by faculties and students' questionnaires show similar attitude of both students and faculties toward a particular resource. This creates the necessary prerequisites for its efficient introduction into the teaching process. Resources with similar students and faculties' scores are located in the vicinity to the diagonal line which is symbolically depicted by a shaded belt in Fig. 1.

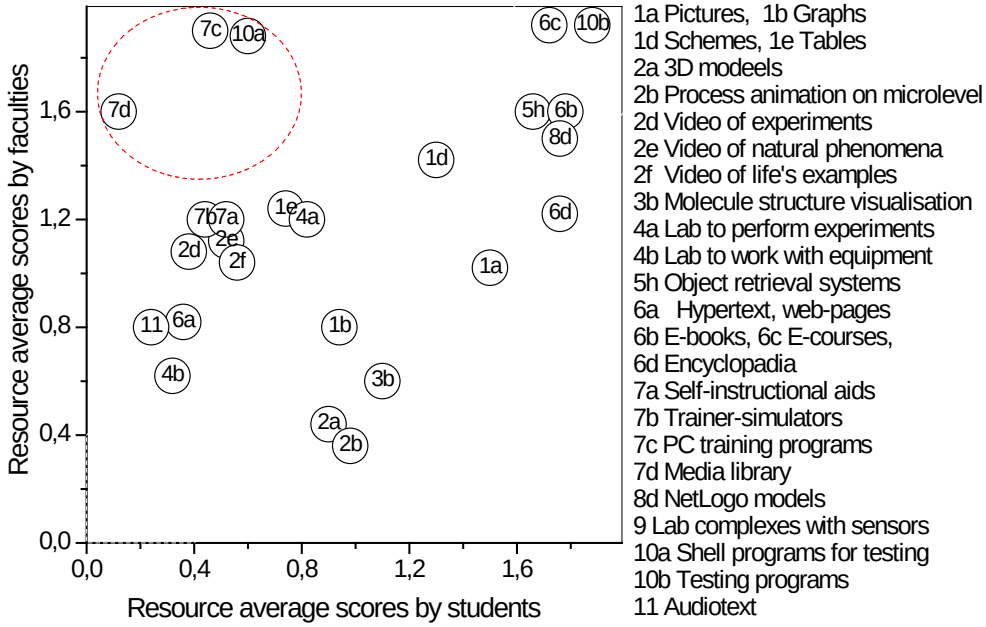

Fig. 1. Relationships between resource average scores used in inorganic chemistry training on the base of students and faculties' responses

Lack of conformity complicates the process of learning. Resources located below the diagonal line have rather limited chances to be used because they are less valued by the faculties compared to the students. Resources located above the diagonal line are more appreciated by the faculties and for this reason they can be used more frequently than others. University teachers of science disciplines typically have personal experience in exploitation of a rather limited number of ICT-LRs. At the same time, they consider themselves as experts in the use of these resources. By this reason, they tend to use just these habitual and known resources. Such tendency was studied in details in [4, 5] where the expertise level and actual preferences with respect to particular ICT-LRs were analyzed for lecturers of some American and Australian universities. However, the resources located above the diagonal in Fig. 1 are not among students' preferences. This may worsen their perception by the audience and reduce efficiency of their use in teaching process.

One of the possible reasons for the discovered difference in students and faculties' attitudes toward electronic resources can be concerned with the difference in their learning styles. Learning style is usually considered as typical, cognitive, emotional and psychological behavior which serves as a flexibly stable indicator of the nature of interaction of a student with learning environment. There are known as many as 70 models to characterize the learning styles [6]. Various models concern various combinations of human activity and characteristics, such as thinking styles, comprehension type, intelligence structure, approaches to learning, decision-making methods, career type, etc [7]. Only some of the available models focus on the educational applications, such as, e.g., identification and control of the potential problems that could appear during learning [8, 9]. In particular, the Index of Learning Style (ILS) by Felder-Soloman is widely used in the context of engineering education. This model categorizes individuals' preferences in the following four dimensions: type (sensitive or intuitive) and mode (visual or verbal) of information perception, approaches to the information processing (active or reflective) and the progress rate towards understanding (sequential or global).

Students of different specialties were found to demonstrate essentially different preferences in terms of the ILS [9, 10]. Moreover, the learning preferences of students and lecturers can be also different. For example, the learning preferences of the survey participants were averaged over all students and faculties respectively. As it is seen from Fig. 2, the faculties are much more reflective and tend to global and intuitive modes compared to more active, sensitive and sequential students.

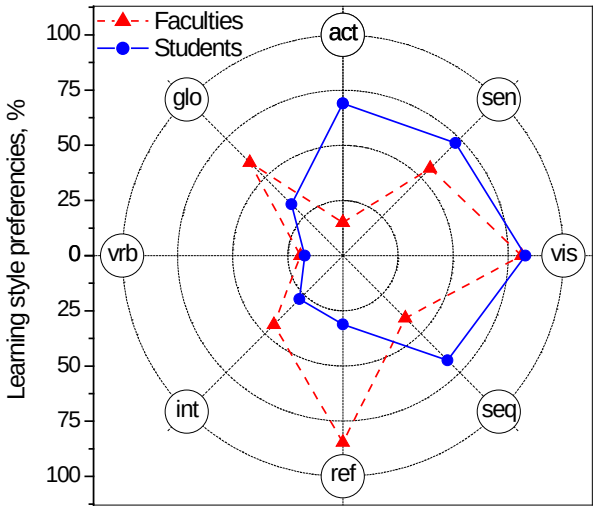

Fig. 2 Learning profiles for students and teachers of Faculty of Chemistry

The revealed difference in students and faculties' attitudes toward various ICT-LRs puts in the forefront the question of teaching and learning styles matching. In our opinion, the optimal teaching style is a balanced one in which all students are sometimes taught in a manner that matches their learning style preferences and sometimes in the opposite manner. This can be achieved by incorporating a variety of teaching styles that, one the one hand, ensures the greatest comfort of students and, on the other hand, allows the teacher to alleviate potential learning style conflicts.

As mentioned before, a preferred learning style is a rather stable characteristic. However, it can be corrected under certain conditions, as supposed in [11]. For example, an increase of the number of reflective students was observed after lessons with computer simulations which were taught by lecturers with preferred reflective styles [12]. Further researches are necessary to verify the flexibility of preferred styles and thus to optimize the teaching process.

Conclusions. Both expediency and the-state-of-the-art in the use of ICT-based learning resources to university course of inorganic chemistry training have been studied by means of expert survey. All studied resources were classified as either universal, which cover more than 40% of all discipline themes, or specific ICT-LRs, which are of principal importance for teaching of a limited number of themes. An optimal resource kit was defined for inorganic chemistry training. It includes 20 universal and 4 specific resources. In contrast to the optimal kit, only 10 universal and 4 specific resources have been already introduced into the practice of chemistry teaching.

An essential difference exists between students and faculty members in their attitudes toward individual resources. This contributes to the loss of efficiency of the use of such resources in chemistry training.

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Применение учебных ресурсов на основе ИКТ для преподавания университетского курса неорганической химии

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Аннотация. Изучены целесообразность и эффективность использования различных учебных ресурсов на основе ИКТ для преподавания университетского курса неорганической химии. Выявлены существенные различия в отношениях студентов и преподавателей к электронным ресурсам, что создает предпосылки для потери эффективности их использования.

Ключевые слова: образовательные ресурсы на основе ИКТ; преподавание неорганической химии; стили обучения.