

# THE APPLICATION OF ICT TOOLS IN CHEMISTRY CLASSES IN HIGH SCHOOLS: A CHALLENGE FOR TEACHERS OF CHEMISTRY TEACHING METHODOLOGY AND SCHOOL PRACTICE AT UNIVERSITIES

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**Abstract:** In this paper, using a questionnaire as a research instrument, the method and measure of the ICT tools application in the teaching process of chemistry in a four-year secondary school in Novi Pazar, Serbia, was examined. The attitudes of first and third year students, as well as their teachers, were examined. It was concluded that there is potential for increased use of ICT tools in the chemistry teaching, that students are very willing and interested in acquisition chemical knowledge using ICT tools. Teachers should be encouraged more in terms of attitudes that the use of ICT tools will not reduce the competence of chemistry teachers, and that the use of ICT tools without expert supervision is not expedient. The conclusions drawn from this preliminary research will serve teachers of Chemistry Teaching Methodology and School Practice at the State University in Novi Pazar to improve their classes.

**Key words:** ICT tools, teachers of Chemistry, competence of teachers.

## 1. INTRODUCTION

The development of modern information and communication technologies and tools (ICT tools) brings with it a wide range of possibilities for their application. At the same time, the rise of new ICT tools is accompanied by numerous challenges related to the limitations of their use, the type and method of application, and the willingness of people to adapt to the innovations that such technological development brings with it [1], [2]. The reasons for insufficient or inadequate use of ICT tools are numerous and varied, and certainly depend on the degree, type and level of education of the users of ICT tools.

If we consider the extent and method of using ICT tools for educational purposes in chemistry classes in secondary schools, then the extent of use of ICT tools primarily depends on the school's equipment on the one hand, and on the capabilities of teachers on the other [3]. The school's readiness to use ICT tools for teaching purposes is something that an individual teacher cannot do much about. On the other hand, the readiness of teachers to use ICT tools in chemistry classes for the purpose of better and easier acquisition of knowledge in the field of chemistry can certainly be improved. Considering that primary and secondary school teachers are educated at faculties for their professional work, faculties and universities play a very important role in the education of future teachers and their preparation for the application of all available modern technologies in teaching [4], [5].

The aim of the research conducted here was to examine the level, method and purpose of applying ICT tools in chemistry classes in a four-year secondary school in Novi Pazar, Serbia. The results obtained from this preliminary research will serve as a basis for teachers of the subject Chemistry Teaching Methodology and School Practice at the State University in Novi Pazar to correct and improve their classes, with the aim of better educating and preparing future chemistry teachers to use ICT tools in their professional work.

## 2. METHODOLOGY SECTION

The research was conducted as part of the implementation of the courses Chemistry Teaching Methodology and School Practice, which are attended by third and fourth year students of the Chemistry study program at the State University in Novi Pazar. A questionnaire was used as an instrument for conducting the research. The questionnaire consisted of three groups of eight questions/statements each. The first group of questions/statements (group A) was intended for

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students, while the other two groups of questions/statements (groups B and C) were intended for chemistry teachers who teach the surveyed students. For each of the listed questions/statements in the questionnaire, the respondents could choose one of the following answers: A = I completely disagree; B = I disagree; C = I am not sure; D = I agree; E = I completely agree. Considering that this preliminary research was conducted in a four-year high school, the total number of students surveyed is 189. Of these, 110 are first-year students, and 79 are third-year students. According to the curriculum of this school, students take chemistry for all four years. In order to obtain teachers' views on the use of ICT in chemistry classes, two teachers were surveyed. One of them is about 50 years old and has about 30 years of work experience. The other surveyed teacher is about 30 years old and has less than 10 years of work experience.

The following are the questions/statements provided in the questionnaire.

Questions/statements of group A intended for students:

- We use the internet in class for learning purposes every week;
- During class, the teacher allows us to use the internet to solve questions and assignments;
- The teacher guides us to use websites that can help us acquire knowledge and solve homework;
- I would like the internet to be used more in chemistry classes;
- During class, we use various mobile applications designed as games according to knowledge levels;
- During class, we use mobile phones and internet as a means of obtaining new informations, respecting the instructions given by the teacher;
- The teacher follows the new scientific discoveries in chemistry and direct us to websites where we can acquire new knowledge and chemistry-related information;
- The teacher plays videos related to the class on TV or video projector.

Questions/statements of group B intended for teachers:

- At my initiative, my students use the internet in class for learning purposes every week;
- During class, I allow the use of the internet for solving questions and assignments;
- I direct students to use websites that can help them acquire knowledge and solve homework;
- I would like the internet to be used more in chemistry classes;
- During review classes, my students, at my initiative, use various mobile applications designed as games according to knowledge levels;
- During class, my students, with my suggestion and supervision, use mobile phones as a means of obtaining new information. I give instructions to students about the rules: how and when to mobile phones and internet;
- I follow the new scientific discoveries in chemistry and direct students to websites where they can acquire new knowledge and chemistry-related information;
- I play videos related to the class on TV or video projectors.

Questions/statements of group C intended for teachers:

- The school where I work / the chemistry classroom has internet access;
- The school where I work / the chemistry classroom has a TV;
- The school where I work / the chemistry classroom has a video projector;
- The use of mobile phones for educational purposes is allowed in the school where I work;
- The application of new ICT reduces teaching competencies;
- The school where I work organizes trainings for teachers on the use of ICT tools to modernize teaching process;
- Students gladly embrace the use of new technologies;
- Students are interested in the material taught in the Chemistry subject.

### 3. RESULTS AND DISCUSSIONS

As can be concluded from the attached groups of questions, the questions from groups A and B, the first of which is intended for students and the second for teachers, are almost identical. With this, we wanted to check how the scope and purpose of ICT tools in chemistry classes looks from the perspective of the students, and how it looks from the perspective of the teacher. The results of this survey are given in Tables 1 and 2.

*Table 1. Indicators of the use of ICT and tools in chemistry classes in the first and third grades of secondary school in Novi Pazar (A group of questions / statements)*

| students             | A (%)      |              | B (%)      |              | C (%)      |              | D (%)      |              | E (%)      |              |
|----------------------|------------|--------------|------------|--------------|------------|--------------|------------|--------------|------------|--------------|
| A(I+III)<br>(110+79) | I<br>class | III<br>class | I<br>class | III<br>class | I<br>class | III<br>class | I<br>class | III<br>class | I<br>class | III<br>class |
| 1.                   | 9.09       | 12.65        | 19.01      | 26.58        | 34.71      | 26.58        | 24.79      | 27.84        | 12.39      | 6.32         |
| 2.                   | 19.83      | 22.78        | 13.22      | 31.64        | 24.79      | 22.78        | 28.09      | 15.18        | 14.04      | 7.59         |
| 3.                   | 7.43       | 20.25        | 15.17      | 11.39        | 12.39      | 27.84        | 38.01      | 20.25        | 26.44      | 20.25        |
| 4.                   | 4.13       | 13.92        | 4.95       | 10.12        | 18.18      | 24.05        | 34.71      | 10.12        | 38.01      | 41.77        |
| 5.                   | 48.76      | 56.96        | 26.44      | 20.25        | 10.74      | 10.12        | 6.61       | 3.79         | 7.43       | 8.86         |
| 6.                   | 19.01      | 25.31        | 22.31      | 25.31        | 21.48      | 16.45        | 23.14      | 20.25        | 14.04      | 12.65        |
| 7.                   | 8.26       | 25.31        | 21.48      | 18.98        | 21.48      | 18.98        | 25.61      | 21.51        | 23.14      | 15.18        |
| 8.                   | 19.01      | 22.78        | 18.18      | 8.86         | 19.83      | 21.51        | 26.44      | 26.58        | 16.52      | 20.25        |

A = I completely disagree; B = I disagree; C = I am not sure; D = I agree; E = I completely agree.

*Table 2. Indicators of the use of ICT and tools in chemistry classes in the first and third grades of secondary school in Novi Pazar (B group of questions / statements)*

| teacher           | A (%)      |              | B (%)      |              | C (%)      |              | D (%)      |              | E (%)      |              |
|-------------------|------------|--------------|------------|--------------|------------|--------------|------------|--------------|------------|--------------|
| B(I+III)<br>(1+1) | I<br>class | III<br>class | I<br>class | III<br>class | I<br>class | III<br>class | I<br>class | III<br>class | I<br>class | III<br>class |
| 1.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 100.00       | 100.00     | 0.00         | 0.00       | 0.00         |
| 2.                | 0.00       | 0.00         | 100.00     | 0.00         | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 100.00       |
| 3.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 0.00         | 100.00     | 0.00         | 0.00       | 100.00       |
| 4.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 100.00       | 0.00       | 0.00         | 100.00     | 0.00         |
| 5.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 0.00         | 100.00     | 0.00         | 0.00       | 100.00       |
| 6.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 100.00       | 100.00     | 0.00         | 0.00       | 0.00         |
| 7.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 0.00         | 100.00     | 0.00         | 0.00       | 100.00       |
| 8.                | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 0.00         | 0.00       | 100.00       | 100.00     | 0.00         |

A = I completely disagree; B = I disagree; C = I am not sure; D = I agree; E = I completely agree.

According to the results presented in Table 1, the majority of first-year students are unsure whether they use internet resources for learning purposes every week, as well as the teacher who teaches this group of students. Among third-year students, the number of those who answered with B, C, and D is balanced, while their teacher believes they use the internet every week for the learning process. The attitudes of both students and teachers regarding the use of the internet in chemistry lessons are generally aligned, indicating that the internet is used for educational purposes in chemistry lessons, although perhaps not every week.

The largest number of first-year students stated that their teacher allows them to use the internet when solving problems during lessons, while the teacher disagreed with this statement. Among third-year students, most believe that the use of the internet for this purpose is not allowed during lessons, whereas the teacher's stance is the complete opposite, claiming that they allow students to use the internet during lessons to solve problems. There is a complete mismatch in responses to this question between teachers and students, as well as among the teachers themselves. The cause of this mismatch could be varied. In order to avoid speculating and offering unsupported assumptions as explanations, the cause of this discrepancy will be the subject of a future, more detailed study.

The highest percentage of first-year students, as well as a significant number of third-year students, stated that their teachers direct them to websites that can help them gain new knowledge and information in the field of chemistry. The students' responses are in agreement with those of their teachers.

The largest number of students of both examined classes would like the Internet to be used more in chemistry classes, which is in agreement with the attitude of the teacher who teaches chemistry to first-year students. On the other hand, the teacher who teaches third-year students is not sure if she/he wants more extensive use of the internet in her/his classes.

The majority of students from both surveyed grades stated that they do not use mobile applications designed as games with different levels of knowledge for acquisition and renewal of chemical knowledge during chemistry lessons. In contrast, the teachers of both grades indicated that their students do use such mobile applications in chemistry lessons. Again, there is a complete disparity between the responses of the students and their teachers. The authors of the text also do not wish to speculate about the reasons for this discrepancy, leaving the clarification of this issue for further research.

The largest number of first-year students are not sure whether they use mobile phones and the Internet in chemistry classes and with the teacher's instructions in order to obtain new information in the field of chemistry. The teachers also gave a similar answer to this question, which indicates that mobile phones and the internet are used moderately in chemistry classes to acquire new knowledge and information.

Although the first and third year teachers stated that they follow modern scientific achievements in the field of chemistry and direct their students to websites where they can get information about the mentioned, the attitude of the first and third year students is that they rarely receive such information from their teachers.

Both teachers and students generally agree that in chemistry classes, a TV or video projector is used to show films related to the content of chemistry lessons.

Teachers' views regarding the reasons why the internet and ICT tools are not used more often in the teaching of chemistry, as well as the equipment of the school that would enable greater use of ICT tools in the teaching of chemistry, are presented in Table 3.

*Table 3. Indicators of the use of ICT and tools in chemistry classes in the first and third grades of secondary school in Novi Pazar (C group of questions / statements)*

| teacher                    | A (%)    |            | B (%)    |            | C (%)    |            | D (%)    |            | E (%)    |            |
|----------------------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|
| <b>C (I+III)<br/>(1+1)</b> | <b>I</b> | <b>III</b> | <b>I</b> | <b>III</b> | <b>I</b> | <b>III</b> | <b>I</b> | <b>III</b> | <b>I</b> | <b>III</b> |
| class                      | class    | class      | class    | class      | class    | class      | class    | class      | class    | class      |
| 1.                         | 0.00     | 0.00       | 0.00     | 0.00       | 100.00   | 0.00       | 0.00     | 0.00       | 0.00     | 100.00     |
| 2.                         | 0.00     | 100.00     | 0.00     | 0.00       | 100.00   | 0.00       | 0.00     | 0.00       | 0.00     | 0.00       |
| 3.                         | 0.00     | 0.00       | 0.00     | 0.00       | 100.00   | 0.00       | 0.00     | 0.00       | 0.00     | 100.00     |
| 4.                         | 0.00     | 0.00       | 0.00     | 0.00       | 100.00   | 100.00     | 0.00     | 0.00       | 0.00     | 0.00       |
| 5.                         | 0.00     | 0.00       | 0.00     | 0.00       | 0.00     | 100.00     | 0.00     | 0.00       | 100.00   | 0.00       |
| 6.                         | 0.00     | 0.00       | 0.00     | 0.00       | 0.00     | 0.00       | 100.00   | 0.00       | 0.00     | 100.00     |
| 7.                         | 0.00     | 0.00       | 0.00     | 0.00       | 0.00     | 0.00       | 0.00     | 0.00       | 100.00   | 100.00     |
| 8.                         | 0.00     | 0.00       | 0.00     | 0.00       | 100.00   | 0.00       | 0.00     | 0.00       | 0.00     | 100.00     |

A = I completely disagree; B = I disagree; C = I am not sure; D = I agree; E = I completely agree.

The results showed that the teacher who teaches chemistry to third-year students stated that the school / chemistry cabinet has internet access and a video projector, but does not have a TV, while the teacher who teaches first-year students stated that she/he is not sure about the availability of these technical possibilities of the school / chemistry cabinet. None of the surveyed teachers is sure if the school where they teach allows the use of mobile phones for educational purposes. The first-year teacher is not sure whether the use of ICT tools affects the reduction of teacher competencies, while the first-year teacher fully agrees that the use of ICT tools reduces teacher competencies. Both

teachers agreed that the school where they work organizes training sessions for teachers with the aim of training in the use of ICT tools and the modernization of the teaching process, as well as the fact that their students are very willing to use new technologies. A teacher who teaches first-year students is not sure if her/his students are interested in the content they learn in chemistry class, while a teacher who teaches third-year students is sure that her/his students are interested in the content of chemistry class.

## 4. CONCLUSIONS

This paper presents the results of a preliminary research conducted in a four-year high school in Novi Pazar. The questionnaire, as a research instrument, was filled out by the first and third grade students of this school and their teachers. The questions/statements contained in the questionnaires aimed to check the level and manner of using ICT tools in order to improve the teaching of Chemistry, as well as the reasons why these tools are used to presented extent in the educational process. The conclusions reached by the authors of this work will be used to improve teaching of the Chemistry Teaching Methodology and School Practice courses attended by chemistry students at the State University in Novi Pazar.

The conducted research led to the following conclusions:

- Although the Internet and ICT tools are used in chemistry classes, there is certainly capacity for their more purposeful use in order to learn chemistry, as well as in order to solve problems and doubts regarding the content of chemistry in secondary schools;
- One of the ways of implementing ICT tools in chemistry classes is the use of games designed according to knowledge levels, the availability of which is increasing every day;
- Although there are a large number of websites that can be used for educational purposes, their use for the purpose of acquiring chemical knowledge can be greater,
- Students are very willing to use ICT tools in chemistry classes, while the attitude of some teachers is that greater use of ICT tools would reduce their competences;
- Although schools organize trainings for teachers whose goal is to better train teachers in the use of ICT tools, given the constant technological development, there is capacity for constant improvement of these trainings;
- Bearing in mind that future chemistry teachers are educated at universities, one of the tasks of teachers of Chemistry Teaching Methodology and School Practice is to introduce their students to new teaching technologies and the possibilities of their application in chemistry teaching, then to introduce them to available applications for mobile phones and games that can be used for the purpose of acquiring chemical knowledge, as well as to follow new educational and technological trends and apply them in the teaching of the subjects they teach;
- Future chemistry teachers should be encouraged that the use of ICT tools will not reduce the competence of teachers, and that without professional supervision of chemistry teachers, the use of any ICT tool may be incompetent and ineffective, and may even lead to wrong conclusions.

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