The state of ICT implementation in institutions of general secondary education: a case of Ukraine

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Abstract. The use of digital technology in various fields of education today is one of the most important trends in the educational process in the world. The article presents the results of the analysis of the current state of implementation of ICT in the educational process of institutions of general secondary education in Ukraine. For this purpose, a survey was conducted among students of the first year of the Zhytomyr Polytechnic State University, within which 17 questions were asked to students related to the use of information and communication technologies in the educational process. As a result of the research, the introduction of the discipline "Educational technologies and digital education" into the training of future information technology specialists was substantiated, as well as the certification educational program "Information systems and cloud technologies in the educational process", designed for general education teachers, educators for higher education institutions, experts in the field of additional educational services, and other professionals.

Keywords: information and communication technologies, massive open online courses, cloud technologies, cloud services, game simulators, simulators, general secondary education institutions.

1   Introduction

The Law of Ukraine "On Education" states that the formation of information and communication competence in students is mandatory [49] because digital competence is recognized by European Union as one of the key competences [25]. As a result, as stated in the conceptual framework of the digitalization of Ukraine, target audiences in the implementation of the state program on digital literacy are elementary school, secondary school, vocational school, and higher education institutions (HEI) [32].

The use of digital technology in various fields of education today is one of the most important trends in the educational process in the world [16; 21; 29; 30]. Such technologies allow making the learning process more qualitative and interesting, because using the media and interactive tools the teacher can introducing the different

methods of working in the classroom: project method, research and development work, educational games, etc. [9; 32; 42; 44; 46; 52].

Also, the latest situation with pandemic spread of COVID-2019 and corresponding measures that cause disruptions in the educational process around the world one more time emphasizes the importance of ICT in Education [14; 36].

The issues of computerization and informatization of the educational process are widely considered in the works of Olga V. Bondarenko [4], Oleksandr Yu. Burov [17], Valerii Yu. Bykov [6], Vita A. Hamaniuk [8], Andrii M. Hurzhii [7], Anna V. Iatsyshyn [51], Olena O. Lavrentieva [19], Oksana M. Markova [27], Iryna S. Mintii [22], Yevhenii O. Modlo [24], Pavlo P. Nechypurenko [26], Serhii A. Rakov [33], Natalya V. Rashevska [34], Lina M. Rybalko [20], Zarema S. Seidametova [35], Serhiy O. Semerikov [23], Svitlana V. Shokaliuk [40], Mariya P. Shyshkina [31], Aleksander V. Spivakovsky [39], Nina F. Talyzina [41], Illia O. Teplytskyi [37], Yurii V. Tryus [43], Vladyslav Ye. Velychko [13], Myroslav I. Zhaldak [50] and others.

Also, the issue of the introduction of various ICT in the educational process of educational institutions is considered by foreign scientists.

In particular, Alkhansa A. Shakeabubakor, Elankovan Sundararajan and Abdul Razak Hamdan considering cloud computing services and applications to improve the productivity of university researchers [38].

Gonzalo Almerich, Natividad Orellana, Jesús Suárez-Rodríguez and Isabel Díaz-García analyze teachers' information and communication technology competences [1]. Sourya Biswas ascertains how cloud computing can help in education [3]. Marwin Britto [5], Snejana Dineva and Veselina Nedeva [10], Silky Bansal, Sawtantar Singh and Amit Kumar [2], Tuncay Ercan [12] considered the use of cloud computing in higher education.

Chipo Dzikite, Yvonne Nsubuga and Vuyisile Nkonki investigated lecturers' competencies in ICT for effective implementation of ICT-integrated teaching and learning in textiles and clothing degree programmes [11]. Dana Hanson-Baldauf and Sandra Hughes Hassell reveals issues the information and communication technology competencies of students enrolled in school library media certification programs [15]. Andreas M. Kaplan and Michael Haenlein analyze the problem of higher education and the digital revolution [18].

The *purpose of this article* is to establish the current state of implementation of ICT in the educational process of institutions of general secondary education in Ukraine.


2   Results

To find out the current state of implementation of various ICT in the educational process of institutions of general secondary education, as well as to form a group of selective disciplines, a survey of students of the first year of the Zhytomyr Polytechnic State University was conducted. In total, 167 respondents participated in the survey.

Students were asked to answer the following questions [28]:

  1. Do you know what application packages are?
 2. Did you study application packages at school/college?

3. What kind of application packages have you studied/reviewed?
4. From which package did you study office application packages (text editors; spreadsheets; database management systems; demo tools)?
5. Do you know what "cloud services" is?
6. Which of the following programs and services is cloud-based?
7. Do you know what massive open online courses are?
8. Do you use these courses at school/college?
9. If the answer to the previous question is "Yes," which one?
10. Have you used massive open online courses for self-study?
11. Did teachers use any other tools when studying programming in Computer Science?
12. If the answer to the previous question is "Yes", what are the tools?
13. Did any information and communication technology tools (curricula, multimedia, simulators, games, virtual laboratories, etc.) be used in the school/college by non-CS teachers?
14. If the answer to the previous question is "Yes", in what lessons did the teachers use such tools?
15. Which one did you enjoy the most and why (also indicate the item on which it was used)?
16. Was the teaching of this subject more interesting using a variety of tools than without using them?
17. What additional services would you like to consider and explore how to use them?

Let us analyze the answers to each question. First question "Do you know what application packages are?" the purpose was to establish whether the first-year students have basic concepts of the school course in Computer Science (CS). The results of the survey indicate that 91% of students have basic concepts, 9% do not (see Figure 1).
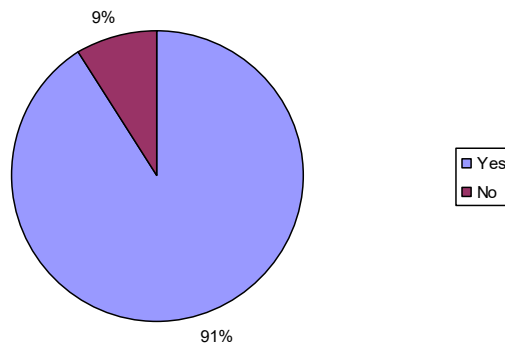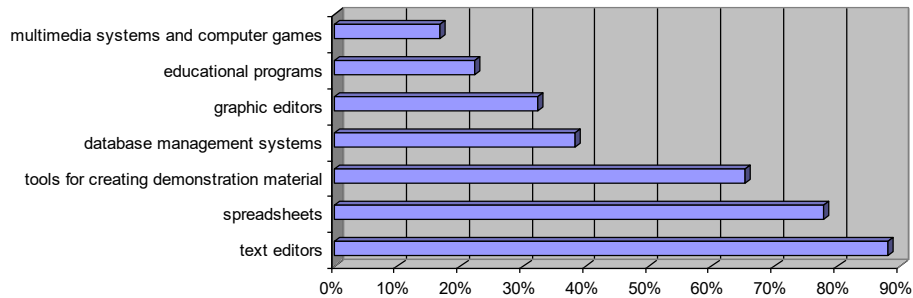

Fig. 1. Percentage of answers to question # 1

Regarding the second question, "Did you study application packages at school/college?", 18% said no and 82% said yes (see Figure 2). This indicates that either the teacher did not adhere to the standard of general education, or the first-year students do not understand the basic concepts of CS.
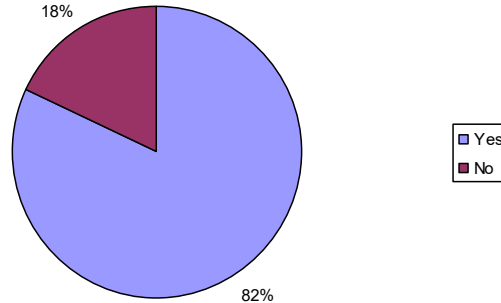
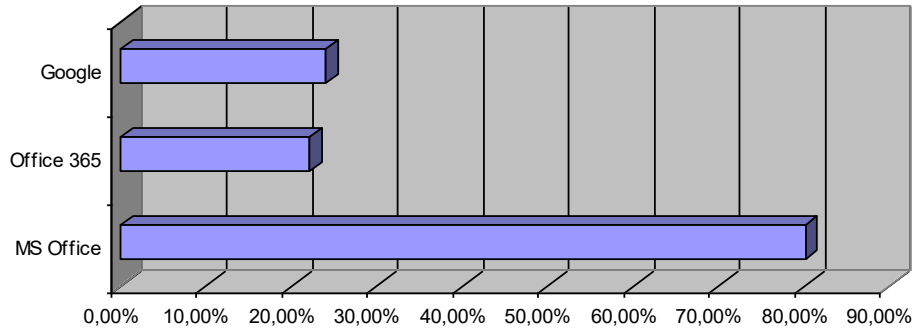**Fig. 2.** Percentage of answers to question # 2

The answer to what exactly served as this distribution of answers to the previous question is to analyze the answers to the following. In response to the question "What kind of application packages have you studied/reviewed?", all 167 respondents chose one of the suggested options, which means that as a student they studied everything they needed, they just did not have the necessary terminology. In this case, 88% of respondents noted that they studied text editors, 77,8% – spreadsheets, 65,3% – tools for creating demonstration material, 38,3% – database management systems, 32,3% – graphic editors, 22,2% – educational programs, 16,8% – multimedia systems and computer games (see Figure 3).

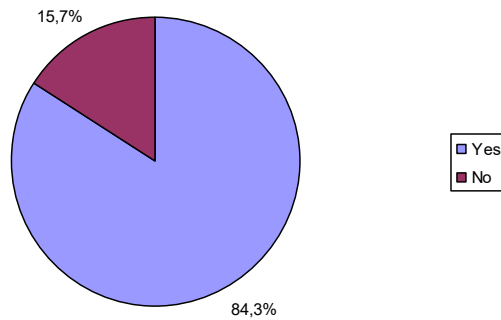**Fig. 3.** Percentage of respondents' answers to question # 3

During the informatization of society, new ICT are constantly appearing, which are replacing the usual applications. One of such ICT is a cloud technology – a service that allows remote use of data processing and storage tools [48].

The next question was to find out whether schools use the standard MS Office suite, or whether some teachers use cloud services. Results of the answers to the question "From which package did you study office application packages (text editors; spreadsheets; database management systems; demo tools)?" 80,2% of those surveyed had studied MS Office, 22,2% had studied Office 365, and 24% had studied Google services (see Figure 4). In particular, 59,3% (99 people) of the proposed list chose MS Office only.

Fig. 4. Percentage of respondents' answers to question # 4

That is why the next question was "Do you know what "cloud services" is?", to which 84,3% answered "yes" and the other 15,7% answered "no" (see Figure 5). Although the study of cloud services is also included in the CS curriculum, not all school teachers adhere to the relevant document.

Fig. 5. Percentage of respondents' answers to question # 5

Answers to the following question "Which of the following programs and services are cloud-based?" are quite interesting as 13,4% of respondents said that MS Office is a cloud service. Also, 12,7% said Office 365 was cloud-based, 82,6% noted Google services, and 7,6% noted Prezi (see Figure 6). It's worth noting that Office 365, Google, and Prezi are among the cloud ones listed.

As Zhytomyr Polytechnic State University actively introduces massive open online courses, the following question "Did you know what massive open online courses are?". The survey results indicate that 74,3% know what it is, the other 25,7% do not (see Figure 7).

In doing so, in response to the question "Do you use these courses at school/college?" 88,6% of students (percent of those who answered "yes" to the previous question) answered, "yes" (see Figure 8).

To find out what kind of open online courses are used in the educational process of general secondary education institutions, the following question was analyzed: "If the answer to the previous question is "Yes", which one?". The analysis of the results

shows that in most cases (50%) are Cisco Academy courses, in some cases (13,6%) are Prometheus, and all others are isolated cases of other courses (see Figure 9). It should be noted that Zhytomyr Polytechnic is closely cooperating with Cisco Academy, as a result of cooperation in the institution of higher education actively used courses of the said academy in the educational process (when studying courses "Computer Networks", "Python Programming", "Cybersecurity").
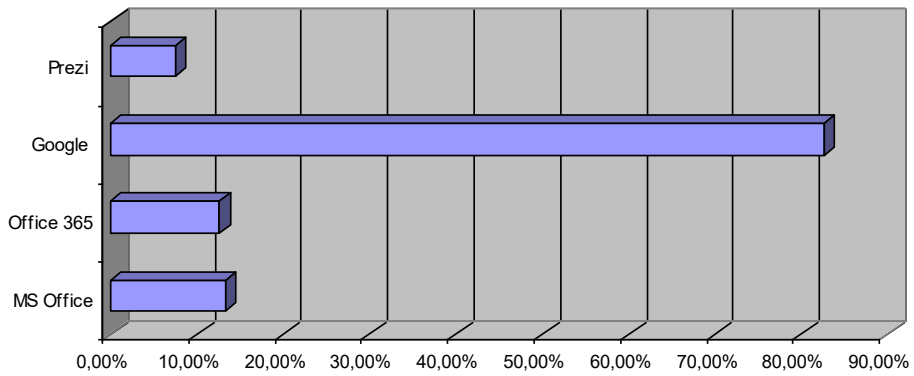

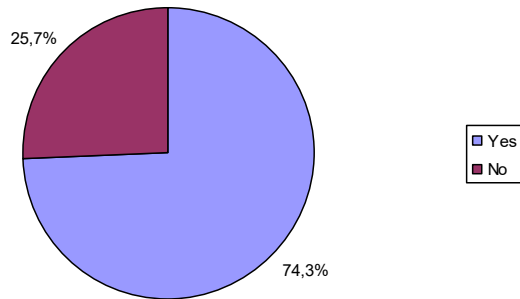**Fig. 6.** Percentage of respondents' answers to question # 6

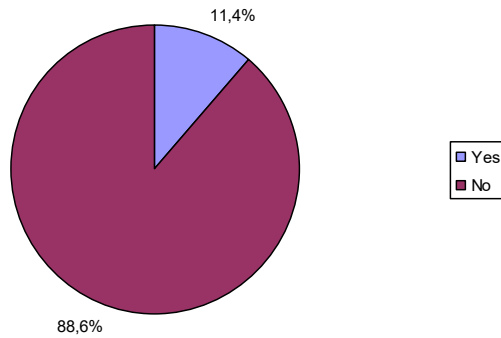**Fig. 7.** Percentage of respondents' answers to question # 7

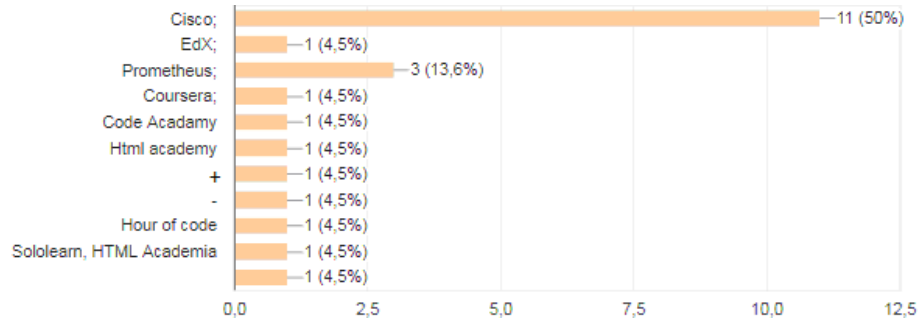**Fig. 8.** Percentage of respondents' answers to question # 8

Fig. 9. Percentage of respondents' answers to question # 9

Also, to facilitate the use of massive open online courses (MOOC) in students' independent work, the following question "Have you used massive open online courses for self-study?" The results of the survey (67,1% – yes, 32,9% – no, see Figure 10) indicate that not all students used MOOC for independent work, and therefore, before using these courses, it is worth conducting coaching for students who do not know how to use such MOOC.
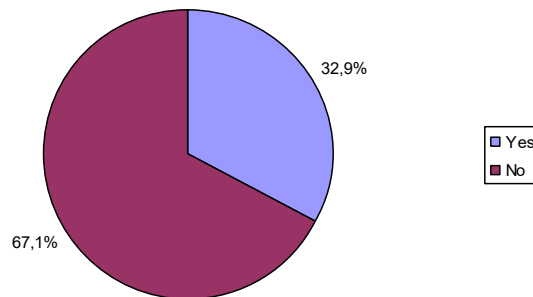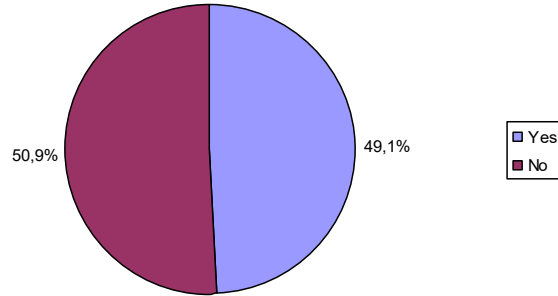

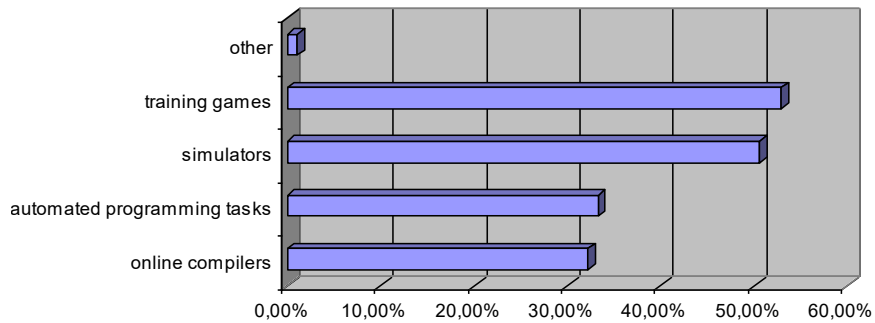**Fig. 10.** Percentage of respondents' answers to question # 10

Also, an important question was, "Did teachers use any other tools when studying programming in Computer Science?", in which 50,9% said "yes, they used", 49,1% – no (see Figure 11).

To find out what kind of tools were still used in CS lessons, the following question was asked: "If the answer to the previous question is "Yes", what are the tools?". The results (see Figure 12) indicate that 32,2% of the respondents worked with online compilers, 33,3% – with automated programming tasks, 50,6% – with simulators, 52,9% – with training games. According to previous research [48], it is with online compilers and automated systems for checking programming tasks that computer teachers want to work in the educational process, but for some reason, they are not used yet.

As ICTs can be used not only in CS lessons, the next question was "Did any information and communication technology tools (curricula, multimedia, simulators, games, virtual laboratories, etc.) be used in the school/college by non-CS teachers?".

Fig. 11. Percentage of respondents' answers to question # 11

Fig. 12. Percentage of respondents' answers to question # 12

Survey results indicate that in 51,5% of cases ICT was used in other lessons, in 48,5% it was not (see Figure 13).
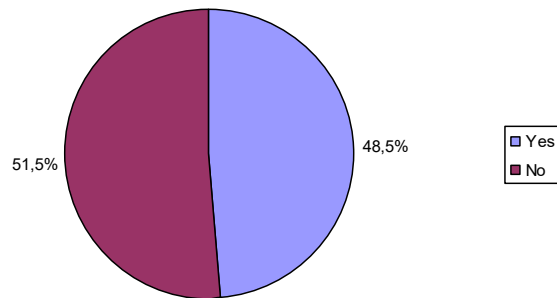
Fig. 13. Percentage of respondents' answers to question # 13

Among those who answered "yes" to the following question "If the answer to the previous question is "Yes", in what lessons did the teachers use such tools?" were distributed as follows (see Figure 14): 50% – ICT used in language and literature lessons; 48,8% – in mathematics lessons; 43,8% – physics; 38,8% – history; 33,8% – chemistry; 30% – biology; 20% – geography etc.
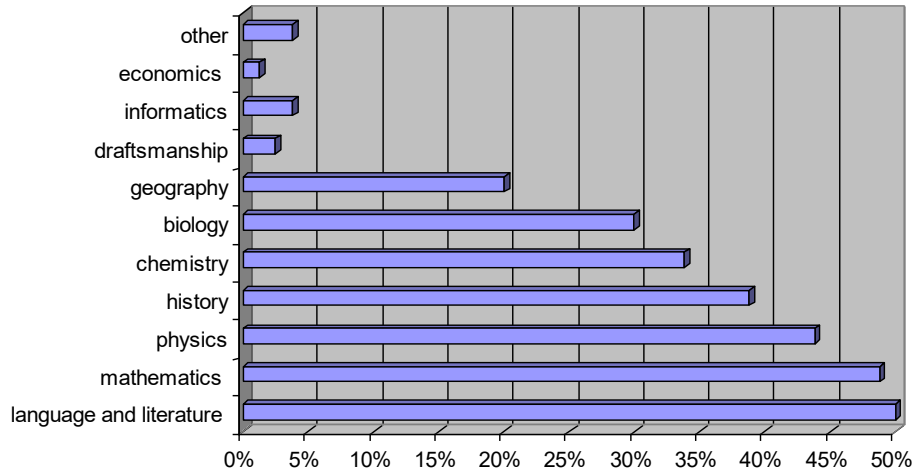
Fig. 14. Percentage of respondents' answers to question # 14

This indicates that most teachers still do not use different ICTs in their activities, although there are currently many tools that can be used in the educational process of a general secondary education institution.

The next question is, "Which one did you enjoy the most and why (also indicate the item on which it was used)?" made it possible for teachers to use the following ICT tools in their activities: multimedia, presentations, games, documentary, online quiz, educational films, simulators, and automated verification systems.

Analysis of the distribution of answers to the question "Was the teaching of this subject more interesting using a variety of tools than without using them?" (see Figure 15) indicate that it is still more interesting for students to use ICT in the educational process than not use.
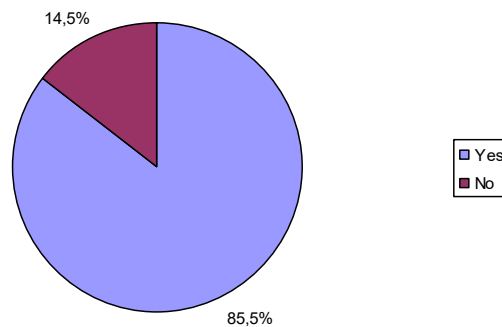
Fig. 15. Percentage of respondents' answers to question # 16

To determine what other services could be considered with students, the answers to the question "What additional services would you like to consider and explore how to use them?" were analyzed. The results show that students want to study game simulators in

detail – 62,3%, cloud services for collaboration on documents – 59,9%, educational games – 45,5%, tools for learning programming – 43,7%, simulators – 41,3%, computer network modeling tools – 35,3%, virtual labs – 34,7%, massive open online courses – 29,9%, statistical data processing tools – 25,7%, cloud services to build distance courses – 24,6%, collaboration tools for project activity – 23,4%, mathematical services – 22,8%, mind maps – 19,8% (see Figure 16).
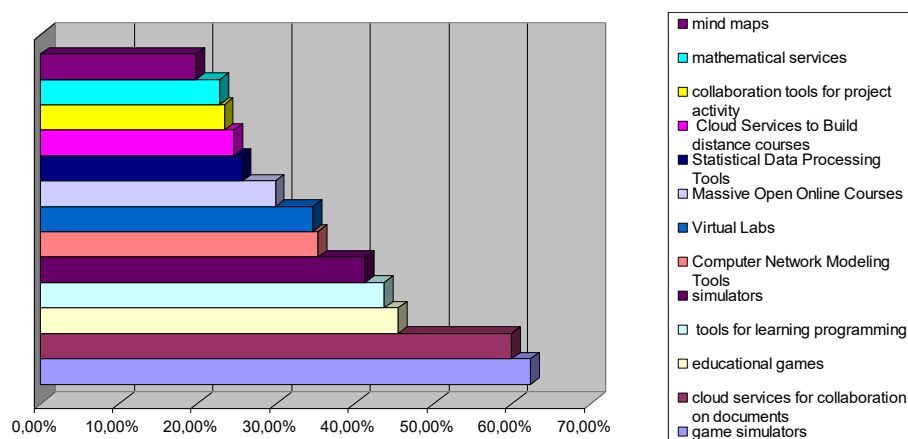

Fig. 16. Percentage of respondents' answers to question # 17

3 Conclusion

As a result of the research, the introduction of the discipline "Educational technologies and digital education" into the training of future information technology specialists was substantiated [45], and the certification program "Information systems and cloud technologies in the educational process" was developed [47], which is aimed at teachers of general schools, teachers of HEI, specialists in the field of additional educational services, and other specialists.

Certified educational program "Information Systems and Cloud Technologies in the Educational Process" aims at forming knowledge about the peculiarities of using information systems and cloud technologies in the educational process of educational institutions, forming the ability to plan, develop courses at the methodological and information-technical levels using modern information systems and cloud technologies, to organize various forms of higher education by applying modern information systems and cloud technologies.

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