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Mobile technologies providing educational activity during classes

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Abstract. Modern mobile technologies have become widespread in our lives. All of us use them every day. The use of mobile phones in education is a topical issue too. This paper presents the methodological features of the use of mobile technologies in the astronomy's class. Modern methods offer a lot of techniques and innovative forms of teaching methods in order to improve students' knowledge. These innovations are aimed to increase using activity-based and person-centered approaches to learning and also, they will help to intensify students' training activities therefore. The including mobile technology in education process will be engage and productive. We used mobile technologies for the organization of practical tasks from astronomy, as well as the possibility of individualization of education is shown. The such tasks help to increase students' cognitive activity. It is presented in the article, as an example for astronomy studying, there is example of mobile phone using for the Moon research.

1. Introduction

Nowadays informatization tendency of society and digital technologies development have an impact on the educational process [1]. Due to the conception of new Ukrainian school [2], a new type of education must be implemented at secondary educational institutions. This type of education, in general, aims at studying and supporting the civilization achievements, form a person being able to implement new innovational changes, to solve the problems which a person faces as well as a society. If earlier students used their computers at home or at informatics lessons, now the most students have a mobile phone, a tablet or an e-book. So, the use of education and development information materials with the use of these devices is a significant pedagogical reserve. Heading the interest in mobile technologies to education, students' cognitive activity may be significantly increased. Such education supposes constant students' involvement into active educational and cognitive activity. This encourages them to initiative, creative approach and active position in all kinds of the mentioned activity; it supposes not only getting but also gaining knowledge and skills, projecting their own world view, student's formation of the key competences, so that increasing the result of educational process [3]. It heads educational skills for the whole life.

Astronomy is the science about the Universe and its development, and the main goal of studying astronomy in secondary educational institutions is the end of formation of world natural



and science picture [4,5]. In the most modern secondary educational institutions astronomy is studied in 11th grade, consequently a paradox appears: students are interested in space and the Universe but they have low motivation to study the astronomy school course. For better students' understanding and absorbing of the material a teacher constantly has to use various visualization aids, using photo, animation, video, schemes, 3D models demonstration. The use of non-standard forms and technologies increases motivation of astronomy studying. The use of interactive tools, multimedia boards, computers or mobile apps in combination with books, as well as combination of educational material with known and interesting information can attract student's attention, also it will stimulate him to more serious and responsible attitude to the subject. So, with the help of the mobile apps they can study starry sky, the Solar system, star building and evolution, as well as observe different astronomical phenomena [6,7]. The quantity of astronomy apps increases but the methods of their use at astronomy lessons are not enough described. Therefore, the relevance of the paper is in the necessity of working out the manuals for implementing the mobile apps use at astronomy lessons for practical classes organization.

2. Problem overview

Increasing devices quantity and their interference into people's life encourage to overthinking the significance and opportunity to get information in different spheres of activity including education. Modern "digital society" has a new thinking type (clip thinking). That's why a teacher must build educational process in a new way and use actively mobile education technologies.

Increasing tendency of mobile phones use in educational aims is observed throughout the world. Students and teachers use these devices in most cases for exchanging the information, consultations with dictionaries and thesauruses [8].

The foundations of mobile learning is still under development [9–11]. Due to the definition [12] mobile learning is a type of distance education and an opportunity of getting and giving educational content on individual mobile tools such as pocket computers, smartphones, tablets, e-books, mobile phones, etc. Educational content is included into digital educational actives which, therefore, include any form of content or media available on an individual mobile device.

Mobile technologies are a wide spectrum of digital and fully portable mobile tools (smartphones, tablets, e-books etc.) that allow to operate with information getting, processing and spreading [13–16]. Mobile technologies improve methods and ways of access to information and its presenting so that leads to the creation of new or improving existing forms of material processing [17,18]. In general, education becomes personalized, accessible and non-restricted by time measures [19]. The main peculiarity of mobile learning differentiating it among other educational technologies is its mobility [20]. Considering the above mentioned pros of mobile learning, it can never substitute traditional education but its proper use can significantly increase the meaning of existing educational styles [21].

Kong in her research [22] studied lecturers' experience in educational mobile systems use. His conclusions defined five topics among which there are (a) lecturers' perception of mobile learning, (b) motivation to use mobile learning, (c) behaviour standards in the mobile learning use, (d) problems with the accepting of mobile learning and (e) advantages of the mobile learning use. Gan and Balakrishnan [23] studies the factors which impact on the mobile learning perception and can improve the interrelation of a lecturer and students during a lecture, in particular, the use easiness, self-effectiveness and satisfaction. In the research devoted to the college lecturers in Kentucky and Tennessee Thomas et al defined the determinants of accepting the mobile learning including Internet access, educational programmes, calculators and calendars. Potential obstacles include students' cheating, inappropriate information in the Internet, threatening in the Internet and failure. Mobile learning in the developing country is studies in the research [24]. The results show opportunity of complex education through knowledge exchange, academic societies

development and immediate communication. Recommended mobile learning can create common educational environments that consequently may broaden active educational opportunities [21].

The theoretical aspects of mobile learning were researched by K. L. Buhaichuk [25], V. Yu. Bykov [26], Y. O. Modlo [18], N. V. Rashevskaya [27], S. O. Semerikov [28], S. V. Shokaliuk [29], K. I. Slovak [9], A. M. Striuk [30], I. O. Teplytskyi [31], V. V. Tkachuk [32] and others.

V. Yu. Bykov [26] researched criteria of mobile learning in the educational process, the use of mobile devices of all types and also their purpose and role in education whereas K. L. Buhaichuk [25] paid attention to didactic opportunities of mobile apps. N. V. Rashevskaya [27] studied advantages and disadvantages of mobile devices use in the students' educational process of higher educational institutions. M. Oprea and K. Miron also pay attention to mobile learning [33]. There are works devoted to the problems of implementation and use of mobile devices via physics teaching. J. Trucksler and M. Oprea [34] emphasize that mobile devices broaden the diapason of time measures of information perception.

The disadvantage of mobile phones use is emphasized in the researches [35] due to their negative impact in children's behaviour. The other researches describe the average and middle level of teachers and students being ready to follow as well as general research tendency [24, 36, 37]. Mobile phones use in the educational process improves cowork between students and lecturers, provides immediate communication, strengthens students' participation and interrelation, encourages authentic education and reflexive practice, also it broadens opportunities for educational societies and changes in lecturers' approaches [8].

The research [8] deals with the lack of being ready to use mobile technologies in the educational process, low experience of mobile devices use is mentioned. So, to get more positive result of mobile technologies implementation in the educational process it is necessary to develop skills and culture of mobile telephones use.

3. Results and discussion

3.1. Information

Nowadays different educational mobile systems, video connection systems, distant courses, mobile apps, electronic publications, lessons, projects, students' progress registers, test schemes, social networks, e-mail are created [38–41]. General recommendations for computer and mobile apps implementation in to the educational process are worked out.

For example, such programmes for teaching different disciplines are used:

- English Platinum 2000, Triple Play Please [40] for teaching foreign languages;
- Multiplication table, Pythagor, Formulas, Math Board, Math Helper [23], Mathway, Algebra Touch [8] for teaching mathematics;
- Geography, Compass for Android for teaching geography;
- Chemistry, Mendeleiev periodic table Android, Merck PTE HD for teaching chemistry;
- Power of Minus Ten – Cells and Genetics, Sleep as Android for teaching biology;
- 3D Anatomy for teaching anatomy;
- Audacity, Test Tone Generator, Angle Meter, Smart Measure, Android Speedometer [42], Constant Table, Learn Physics, Serious Physics, Physics at school, Physics. Formulas 7-11, Physics, Physical calculator for teaching physics.

The articles [42–49] considered the issues of mobile phones use at school physics lessons.

The use of computer and mobile apps in astronomy are offered by Iryna Pakhomova on her website [50], also the examples of getting data from apps to solve the astronomy tasks are presented in the work [51]. There are websites where the use of astronomy mobile apps is described.

The most scientists define some important positive moments that significantly increases teaching effectiveness:

- personalized education,
- immediate feedback,
- effective use of educational time at lessons,
- continuity of the educational process,
- qualitative new level of educational process management.

Mobile devices are usually students' possession and that's why students can use them the whole day and not only at the lessons. Therefore mobile technologies allow to individualize more particular student's education, to create conditions in respect to which a student will have his own tasks that take into account his skills and inclinations, interests and experience. A student will be able to use his mobile device for tasks fulfillment (task solution, text reading, watching the content having educational content etc.) in convenient time for him. At the same time "personalization" has also another meaning which is related to collecting information about mobile technologies users. Different users prefer different ways and forms of information watching and perception (tables, diagrams, texts etc.). So, personalized technologies development will allow students to choose the form of information reading in future.

One more important aspect of personalized education is different tempo of educational material absorbing for students with not equal abilities. The use of traditional methods of teaching and information and communication technologies, connected with desktop computers, allowed only partially to differentiate new information presenting and absorbing for the students with different educational abilities. The use of mobile devices significantly broadens the measures of educational material presenting and absorbing. It is connected with the opportunity of their use out classrooms. In such a way, mobile technologies correspond person-oriented approach to education and increase it to the qualitative new level.

Astronomy due to its meaning is a visual science and has certain practical direction, in particular, it is presented in the ground navigation due to the position of celestial bodies, geographical position determination, time measurement, gaining skills of the use of angle-measuring and optical instruments, task solving with the use of formulas of astronomical calendar and map of starry sky. Students' knowledge and practical skills in astronomy must be tightly connected with modern state of science and manufacture, correlate with demands of new high-tech society.

Computer and mobile phone use broadens opportunities also in teaching astronomy. These are computer and mobile planetariums, astronomical database, 3D models, animations, atlases of space objects images, in particular, images of planets and their satellites got with the help of rocket and space tools, simulators, computer tests and self-control of knowledge. Interactive apps due to their didactic purpose may be divided into:

- demonstrative,
- educational,
- controlling,
- trainers,
- imitative (simulators).

The programmes that are included to the first group demonstrate astronomical phenomena, processes etc. Such programmes can be used for new material demonstration and illustration. Models made for calculation celestial bodies coordinates, also they can be used for holding practical and laboratory classes, demonstrating the methods of task solving, experimental task fulfilling, for control and self-control. Programme-trainers and imitating models (simulators)

may be used at laboratory and research works. Immediate feedback is reached with the help of the use of mobile programmes or platforms (aimed to be used on mobile devices or computers) having a goal to assess training results faster and to monitor gained results by students.

To automatize the process of gathering, analysis and defining transcripts about students' training success on the classes we can use the platform Plickers for mobile phones [14]. The assessment of students' answers arises immediately and a teacher can see the information on his screen, in particular, about the quantity of right and false answers with mentioned students' surnames, diagram of general quantity of answers. This allows teacher to predict further steps at the lesson in choosing the educational material (which was absorbed by students not thoroughly) for re-review.

A big quantity of other mobile apps, platforms and resources exist (Google Forms, Survey Monkey, Kahoot!, Socrative etc.), with the help of which a teacher has an opportunity quickly to assess students' knowledge and skills. As a rule, these programmes can work on different operational systems (Windows, Linux, macOS, Android, iOS), so that a student can answer on control questions or take a test on his own mobile device, not from a desktop computer of an educational institution.

Mobile apps are better to use not on the certain astronomy lessons but during the whole educational process. At first, students get acquainted with an app, get skills how to use it, and then during learning of peculiar topics students accomplish different tasks of practical character, get new knowledge and reinforce the old one. As experience shows, at the beginning students are interested in the use of apps and spend a lot of time for studying possibilities of any app, but sooner or later with teacher's clear instructions students quickly accomplish tasks. Not to waste the time it is recommended to give practical tasks with the use of mobile apps as a homework.

There are a lot of mobile apps of educational aim and, as a rule, they have different purposes:

- guides or encyclopedias,
- quizzes or tests,
- e-books,
- star maps,
- virtual travellings,
- 3D models.

To learn the building and celestial bodies of the Solar system except the use of photos, maquettes and video we can use special apps like planetariums that allow not only virtually to travel throughout the Solar system but also to study the characteristics of planets, satellites, comets and asteroids. With the help of planets 3D models students can study the type and size of planets. There are a lot of such apps and most of them have similar structure and opportunities: Solar System Scope, Solar Walk 2, Amazing Space Journey etc. (description and opportunities of their use are presented in [52]).

There are such mobile planetariums like Stellarium, Sky Map, Google Sky Map, SkySafari, Star Chart, Star Walk, Star Walk2 and Solar Walk, etc. Descriptions of work with these programmes are presented in the Internet. Using these apps we can study observable motion of the Sun, observable motions of planets, their building and physical characteristics and also other planets of the Solar system. Kepler's laws. Accomplishing such tasks students have their spherical imagination developed, they understand astronomical phenomena and terms well, they can easily orientate on the ground with the help of position of the Sun and other celestial bodies.

3.2. Experiment

Holding astronomy classes with the help of information and communication technologies, in particular, mobile apps provides students' gaining not only subject competences but also it

creates additional opportunities for laboratory experiments in the conditions of virtual reality existence. Person-oriented education, fast access to information, easy form of checking knowledge are provided during this process. The use of mobile apps was offered to the students of the faculty of physics and mathematics and 11th form students. There were no serious problems except those that were described in the previous works (Internet access, storage volume, battery charge, mobile phone quality). School students occurred to be less ready to use mobile phones for practical tasks accomplishment. However, when computer analogues to mobile apps were offered, they preferred to use mobile ones. This can be explained with the fact that mobile phones are all the time available and they can be used any time, also all the students have mobile phones of better or worse quality, and a home computer may be used by some family members.

Here is one of the tasks offered to students: the research of motion of the Moon and the study of Moon surface.

The programme Moon Globe may be used for the study of Moon surface (figure 1). The detailed Moon map allows to study lunar craters, mares and mountains. The app defines user’s place and shows Moon location. Also, you can turn on another regime and turn the Earth satellite to any side in order to see everything thoroughly. To study Moon landscape students can be offered to use this app or some similar and to accomplish such tasks:

- Find on the Moon surface seas; Sea of Crises, Sea of Tranquility, Sea of Nectar, Sea of Cold, Sea of Showers, Sea of Cleverness, Sea of Clouds, Sea of Moisture, and Ocean of Storms; craters: Ptolemy, Alphonsus, Copernicus, Kepler, Aristarchus, Herodotus; mountains: Teneriffe, Montes Recti, Montes Alpes, Montes Caucasus, Montes Apenninus, Montes Taurus; Piton, Pico.
- Write down 5 names of seas, craters and mountains that are the largest.
- Find craters which are called after famous people.
- Compare observable Moon side with non-observable one (that can’t be seen form Earth).

Observable Moon motion with stars backside shows the real Moon motion around Earth which is followed by the changes of our satellite appearance. We can study Moon motion and its phases with the help of mobile apps Moon Phases (figure 2). This app is designed by M2Catalyst for Android, it is free and has Ukrainian language interface. The app contains the information about Moon rise and set, lunar phase, distance to Earth and the constellation of stars the Moon is in. You can get the information for any date, it is enough to turn Moon image.

This app can be offered for students to study motion and conditions of Moon observance: Moon motion on celestial sphere during a month; synodic and sidereal Moon; lunar phases, attribution of Moon position on the starry sky in different phases; Moon position relatively to the horizon in different spheres. To accomplish this task we offer student to fulfill such a table 1 based on data for the straight month.

Table 1. Example of task for student.

Data	Day in lunar calendar	Time of rise	Time of set	Phase (lighting)	Location on the stellarium

Here is the example (table 2) of such task accomplishment.



Figure 1. Interface of Moon globe.

Having fulfilled the table students are to analyze the data and make conclusions about:

- Time during which the Moon changes its phase (synodic period).
- Time during which the Moon makes Earth revolution (sidereal period). To do this a student must analyze the time when the Moon returns to the same constellation of stars.
- How the Moon moves on the starry sky. Pay attention that the Moon goes through all of the zodiac constellation of stars so that Moon motion as Sun motion is projected on the ecliptic.
- The time of Moon location over the horizon.
- Pay attention at dates of lunar phases, interval between young Moon (new moon. 0%), first quarter (25%), third quarter (25%), full moon (100%).
- The best observance conditions. It may be difficult for students to do this independently, so a teacher asking additional questions can help to get their own conclusions. To accomplish this it is necessary to analyze the time of Moon rise and set and lunar phase. If the phase is 0%, the Moon is over the horizon at noon and it cannot be observed. Moreover to observe Moon with the help of telescope during the light part of the day is irrational as craters and mares on the Moon surface are not distinct.

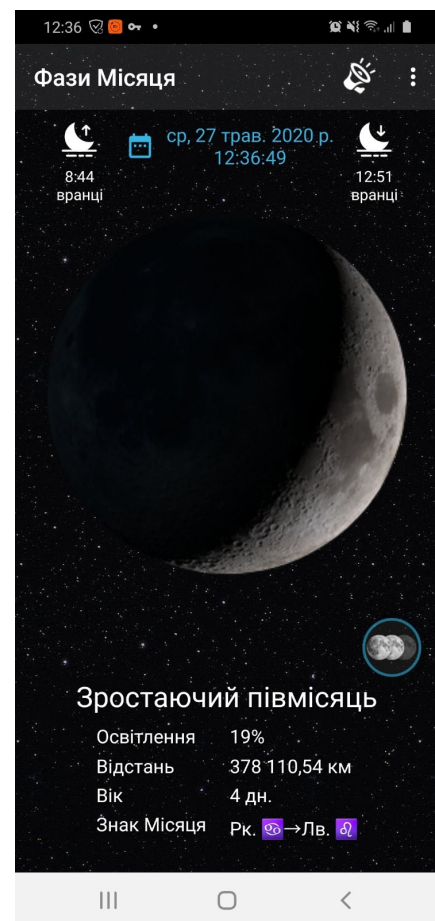


Figure 2. Interface of Moon Phases.

Table 2. Example of task for student (completed).

Day in lunar calendar	Time of rise	Time of set	Phase (lighting)	Location on the stellarium
0	6:59	17:01	0	Aquarius → Pisces
1	7:23	18:05	1	Pisces
2	7:44	19:01	4	Pisces → Aries
3	8:03	20:11	8	Aries
4	8:22	21:14	15	Aries
5	8:41	22:17	22	Aries → Taurus
6	9:01	23:22	31	Taurus
7	9:26	0:27	40	Aries → Taurus
8	9:55	1:34	50	Gemini
9	10:30	2:39	60	Gemini
10	11:15	3:39	70	Gemini → Cancer
11	12:11	4:32	80	Cancer
12	13:19	5:17	87	Cancer → Leo
13	14:35	5:54	94	Leo
14	15:57	6:26	98	Leo → Virgo
15	17:20	6:53	100	Virgo
16	18:43	7:19	99	Virgo → Libra
17	20:06	7:45	94	Libra
18	21:28	8:11	87	Libra → Scorpio
19	22:37	8:36	81	Scorpio
20	23:47	9:02	71	Scorpio → Sagittarian
21	0:04	9:26	61	Sagittarian
22	1:15	9:57	50	Sagittarian → Capricorn
23	2:19	10:46	40	Capricorn
24	3:13	11:42	30	Capricorn
25	3:58	12:43	21	Capricorn → Aquarius
26	4:34	13:47	14	Aquarius
27	5:03	14:52	8	Aquarius → Pisces
28	5:28	15:56	4	Pisces
29	5:50	17:00	1	Aquarius → Pisces

After the full moon it rises very later, in the third quarter, the Moon can be observed in the second half of night and in the morning so to organize school Moon observance during this period will be difficult. That's why a teacher together with students must conclude that the best period to study Moon surface is the first quarter (the Moon can be observed in the evening and in the first part of night).

Such task accomplishment is exciting for students, it has problem character and the conclusion made by students (with a teacher) are similar to their own scientific research. Students can easily remember this knowledge.

Such type of practical class was offered to university students and they demonstrated research traits, also they conducted the observance with great interest and made their own conclusions. The main result was that after such a task they could easily define if the Moon was observable in the sky, when (which date to choose) they need to organize evening Moon observance with

the help of telescope (i.e. the Moon will be over the horizon in the evening and first part of night), got to know relief details of the lunar surface.

4. Conclusions

The practice of telling school students about the Universe apparition or about black holes with the use of an ordinary textbook or in simple terms is not effective. Abstract data hardly can impress someone. The use of visual materials is far another idea, especially, added with 3D images and the use of mobile apps to organize practical classes. There are really a lot of relevant resources in astronomy. Some apps are really familiar to the students but they do not use them for study.

The approbation of mobile apps use showed that students are ready to use them during the educational process even though it demanded more detailed instruction of app use, also it increased students' interest in the accomplishment of these tasks. Moreover, such tasks change education from explaining and illustrative to partly studying and even research method which provides much higher level of cognitive activity activization.

The analysis of methodic peculiarities of mobile technologies use in the educational process in astronomy makes the base to make such conclusions:

- the formation of students' information and digital competence as a key oine in modern world supposes a wide use of information and communication technologies in the educational process, especially the mobile technologies use in the educational process;
- mobile learning at secondary educational establishments has more advantages in comparison to the traditional use of information and communication technologies in education. It can be explained with rapid spreading of mobile devices and apps as well as their accessibility. But a significant need of implementing mobile learning is methodic working out of methods and ways of mobile devices and apps use in different didactic situations;
- school students even senior ones are not ready enough to implementing mobile technologies into the educational activity, even though they master enough mobile devices and some apps and services. Unfortunately, students and teachers are not ready to use educational potential of many mobile apps. That points at the fact that implementation of mobile learning demands purposeful training both students and teachers for such educational activity, particularly, to use the way of highlighting methodic peculiarities of the use of mobile learning techniques in the educational practice.

It should be pointed also problems and difficulties that take place during mobile technologies implementation:

- the students may have mobile devices with different technical characteristics (or different operational systems) that can make impossible to install certain apps and therefor effective devices use at the lesson;
- students' mobile devices may have low battery charge (or its low power) and therefor quickly discharge during the lesson;
- poor mobile Internet (absent Wi-Fi) may take place at school location and therefor it can be an obstacle for the use of online resources;
- children may feel jealous to the classmates who have devices with better parameters (newer, more power-ful);
- it is difficult to organize educational process in such a way that students will not distract at unwanted apps or Internet-services and also if an educator does not know about the opportunities to use mobile devices for his subject study.

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