Application of Blended Learning in Course of C++ Programming at Moscow University of Geodesy and Cartography under COVID-19

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Abstract:

The CORONAVIRUS/COVID-19 pandemic had a significant impact on the programming training of cartographers and surveyors at the Moscow University of Geodesy and Cartography (MIIGAiK). In the spring of 2020, the educational process at the MIIGAiK was reorganized as distance learning, and the academic semester and examination sessions were held remotely. In 2021 year the educational process at the MIIGAiK was reorganized as blended learning. Some practical disciplines, such as Applied Geodesy, cannot be taught in a fully remote format. Training in working with geodetic instruments, for example, working with a theodolite, level, and others requires practical exercises in the classroom. Blended learning is best suited for these disciplines. In this case, theoretical knowledge is transferred to students using remote means, and practical work with geodetic instruments is carried out under the supervision of a teacher in the classroom.

As for programming in C++, blended learning allows the teacher to conduct the main educational process by e-learning, but to check the outcomes in the form of a classic exam in the classroom. The experience gained allows formulating important features of the educational process in these conditions. The role of video lectures in the educational process has significantly increased, and now this is an indisputable fact. Many teachers prepared their lectures in video format. For this purpose, programs such as Zoom, Mind, MOODLE, and others were used. Zoom and Mind allow conducting video lectures, both interactively and in the mode of pre-recording a lecture on a computer disk. Training courses based on video lectures provide substantial assistance to students in mastering the training material.

If we try to compare video lectures and conventional ones in terms of efficiency and convenience of acquiring knowledge, it turns out that face-to-face lectures do not always possess a leading position. The main advantage of a video lecture is the ability to stop the lecture, "pause" it to analyze some complex issues, think it over, and examine in detail what the lecturer said. It is no secret that the large amount of information presented by the lecturer exhausts students and makes the assimilation of educational material by the end of the lecture superficial and ineffective. The video lecture can be stopped at any time, a student has an option to relax and further continue studying the material. It is also possible to re-listen and watch the video lecture at the end of the training course to remind the material before passing the exam. A video lecture allows the student to repeatedly listen and watch the material being studied and solve problems at the moment they appear, and not after the end of the lecture, as it is often the case in conventional lectures. This is crucial because it allows restoring the logical chain of reasoning of the lecturer, and not losing the thread of the lecture. We also note that lectures, even by an experienced lecturer, can contain erratum and unnecessary technical issues. Such insignificant fragments can be removed from the lecture during the editing of the videos which will make them more consistent and accessible to the audience.

In the educational process, three main components of blended learning are implemented. They are distance lectures, distance practicals, and distance examinations or assessments of the students' knowledge. When it comes to teaching C++ programming, distance lectures and practicals were less affected than the distance exam. Indeed, it is currently difficult to determine which way of teaching is more effective in classrooms or online. The same is true in the case of practical. Obviously, there is no need to complete the programming task having the entire group of students in the classroom. It's quite possible to work on it at home. The assessment of the knowledge, conducting examinations and tests remains a complicated process. This is probably the most problematic part of the learning process in terms of a pandemic. A remote exam with an electronic paper ticket gives the student the opportunity to think about the written answer but does not prohibit finding the answer on the Internet. Since there is no way to conduct a remote exam without the Internet, it is necessary to stop writing answers to the paper. Online testing should be used instead of electronic

examination tickets. Computer testing is well known, widely used, and should be an alternative to exam tickets. The peculiarity of online testing is its rapid style, and the testing program sets an intense rhythm for the exam, so there is no time to look for answers on the Internet. To maintain a fast pace of the exam, each question is accompanied by a set of answers, and a student must choose the correct one. Lack of time for searching for the answers on the Internet is the main advantage of online examination tests.

Effective blended learning is based on a carefully designed and tailored learning process. If we are talking about the use of blended learning in C++ programming, then the development and application of computer program examples of a sufficient level of accessibility for beginners come to the fore. Since the blended learning model assumes a more independent study of C++ programming than work in the classroom. For example, let's consider performing simple arithmetic calculations using the program development environment, and display the results of calculations in the format accepted in geodesy. Several computational examples taken from the theory of errors in geodetic measurements would illustrate the task.

Example 1. True errors of ten equally accurate measurements of a certain known horizontal angle on the ground are –5″, +1″, +2″, –3″, –2″, +4″, –4″, 0″, –3″, +4″. It is required to calculate the mean error of the angular measurement data.

Example 2. The same line was measured on the ground by 4 teams of students. The first team measured the line 4 times, the second team measured it 7 times, the third team performed measurement 5 times, and the fourth team measured the line 3 times. The results of measurements are shown in Table 1. It is required to calculate the general mean or the weighted average of the line length.

Team number	1	2	3	4
Line length, m	127.456	127.450	127.461	127.443

Table 1. Results of measurements line length.

Example 3. The angle on the ground was measured with the same tool twice. The first measurement was completed in four steps, the average equals 45°01'00". The second time the measurement was carried out in six steps, the average equals 44 ° 59'30 ". It is necessary to calculate the most reliable value of the angle.

The program shown in listing performs the calculations of the above-given examples.

```
01: #include <iostream>
02: #include <iomanip>
03: using namespace std;
04:
05: int main (void)
06: {
07:     cout << " Mean error of angle measurements: "<<"-" << (5 + 1 + 2 + 3 + 2 + 4 + 4 + 3 + 4)/10.0
07:          << "\"" <<"..." << "+" <<(5 + 1 + 2 + 3 + 2 + 4 + 4 + 3 + 4)/10.0  << "\""  << endl;
08:     cout << " Weighted average of the line length: " << setprecision(6) << (127.456*4 + 127.450*7 +          \
08:          127.461*5 + 127.443*3) /(4 + 7 + 5 + 3)  << " m" << endl;
09:     cout.fill('0');
10:     cout << " The most reliable value of angle measurements :"<< ((45*3600+1*60+0)*4 + (44* 3600 +          \
10:          59*60+30)*6)/(4+6)  /3600 << char(248);
11:     cout << setw(2) << ((45*3600+1*60+0)*4+(44*3600+59*60+30)*6) /(4+6)/60%60  << "\'";
12:     cout << setw(2) << ((45*3600+1*60+0)*4+(44*3600+59*60+30)*6) /(4+6)%60  << "\""  << endl;
13:   return 0;
14: }
```

The program and these exercises can be used in blended learning mode to start familiarizing students with C++ programming. The program illustrates the use of basic arithmetic operators. Students learn the theory of errors at the beginning of a general surveying course and are ready for such an example in a C++ programming.