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Flipped classroom for learning of traumatology and orthopedics during war period in Ukraine

Dudko Oleksii

PhD, Associate professor, Associate professor of the Department of Traumatology, Orthopaedics and Neurosurgery, Bukovinian State Medical University, sq. Teatralna 2, 58002, Chernivtsi, Ukraine, <https://orcid.org/0000-0003-1848-5053>

Glubochenko Olena

PhD, Associate professor, Associate professor of the Department of Propedeutics of Internal Diseases, Bukovinian State Medical University, sq. Teatralna 2, 58002, Chernivtsi, Ukraine, <https://orcid.org/0000-0002-4820-1173>

Dudko Volodimir

teacher of “I_study_class” language learning school, Chernivtsi, Ukraine;
student of higher education in the Institute of Physical, Technical and Computer Sciences, Yuri Fedkovych Chernivtsi National University, Kotsubinskogo street 2, 58012, Chernivtsi, Ukraine, <https://orcid.org/0009-0004-1696-2893>

Hlubochenko Volodimir

PhD, Associate professor, Associate professor of the Department of Internal Medicine, Bukovinian State Medical University, sq. Teatralna 2, 58002, Chernivtsi, Ukraine, <https://orcid.org/0000-0003-1891-5551>

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Abstract. *Flipped classroom teaching approach is considered to be beneficial for students learning. Due to the war in Ukraine the state of professional medical education in the country was significantly diminished therefore it requires searching for improvements. As the rate of civil and war injuries have been increasing significantly, the Traumatology and Orthopaedics should be considered as one of the prioritized courses in medical education. That is why the analysis and implementation of new teaching approaches are going on, trying to create optimal conditions for every student.*

Objective of the study was to assess the educational process on Traumatology and Orthopaedics, to analyze the different types of students' learning activity comparing flipped education alone and in combination with attending online lectures and searching the way to implement new components of flipped education.

Materials and methods. *The relation between final module score on Traumatology and Orthopaedics and amount of attended online lectures were assessed for English speaking students involved in this retrospective study. The components of flipped education were available for all students. The educational materials – methodical instructions, prerecorded lectures, and tests for self-control were accessible for all students on distant learning website of our University before every practical class. So attending online lectures was the only difference between students learning approach. Statistical analysis was performed to calculate average final scores for students with different number of attended lectures ($M \pm m$) and Pearson correlation coefficient between these variables. The final Module score was assessed at the end of the course with the minimum pass score of 124 and maximum of 200.*

Results and discussion. *The average students' final Module score was 151.63 ± 11.75 ($n=65$). For students that have attended all lectures the score was 152.82 ± 12.48 ($n=28$). For students that attended 60% and 80% of lectures the score was 146.17 ± 6.22 ($n=6$) and 151.61 ± 11.66 ($n=31$) respectively. Pearson correlation coefficient was $r=0.12$ ($p=0.178$), that means weak positive correlation. It indicates*



the positive effect of online lectures in educational process. As null hypothesis that there is no correlation can't be rejected due to the lack of statistical power, so we should state, that just online components of flipped education can provide high educational level and allow students to be well prepared for practical classes.

Conclusion. *The study showed that adding components of flipped education to the previously used teaching approach is improving educational process for medical students and can be used within the approved educational program during Traumatology and Orthopaedics course. We consider the further studies are perspective involving more students and assessing the influence of each factor of both classical and flipped educational approach in final students score on traumatology and orthopaedics.*

Keywords: *flipped classroom, learning process, education quality, traumatology, orthopaedics, professional skills, war period.*

Перевернутий клас у навчанні травматології та ортопедії під час військового стану в Україні

Дудко Олексій Геннадійович

канд. мед. наук, доцент, доцент кафедри травматології, ортопедії та нейрохірургії, Буковинський державний медичний університет, Театральна площа, 2. 58002, м. Чернівці, Україна, <https://orcid.org/0000-0003-1848-5053>

Глубоченко Олена Володимирівна

канд. мед. наук, доцент, доцент кафедри пропедевтики внутрішніх хвороб, Буковинський державний медичний університет, Театральна площа, 2. 58002, м. Чернівці, Україна, <https://orcid.org/0000-0002-4820-1173>



Дудко Володимир Олексійович

викладач мовного навчального центру “I_study_class”, Чернівці, Україна; здобувач вищої освіти у Навчально науковому інституті фізико-технічних та комп’ютерних наук за фахом інженер програмного забезпечення, Чернівецький національний університет імені Юрія Федьковича, м. Чернівці, вул. Коцюбинського 2, 58012, Україна, <https://orcid.org/0009-0004-1696-2893>

Глубоченко Володимир Григорович

канд. мед. наук, доцент, доцент кафедри внутрішньої медицини, Буковинський державний медичний університет, Театральна площа, 2. 58002, м. Чернівці, Україна, <https://orcid.org/0000-0003-1891-5551>

***Анотація.** Навчальний підхід з використанням методики оберненого класу вважається одним з найбільш сприятливих для навчання студентів. Під час військового стану в Україні рівень професійної медичної освіти в країні суттєво пригнічений і потребує пошуку засобів, що можуть його покращити. Травматологія та ортопедія є однією з пріоритетних навчальних дисциплін у медичній освіті, оскільки кількість травмованих, як серед мирного населення так і військових зростає. Тому постійно проводиться аналіз і впровадження нових підходів до навчання з метою створення оптимальних умов для кожного студента.*

***Метою** було оцінити навчальний процес з травматології та ортопедії, проаналізувавши різні види навчальної активності, порівнюючи студентів, що навчалися тільки з компонентами перевернутого класу та в його поєднанні з відвідуванням лекцій за допомогою онлайн доступу.*

***Матеріали і методи.** В ході ретроспективного вивчення було вивчено залежність загального балу англomовних студентів з дисципліни «Травматологія та ортопедія» від кількості відвіданих онлайн лекцій. Компоненти оберненого класу були доступні для всіх студентів. Навчальні*



матеріали – методичні вказівки, відео файли з лекціями, тести для самооцінки були доступні для студентів на сайті дистанційного навчання нашого університету до проведення практичного заняття. Таким чином, навчання студентів відрізнялося тільки відвідуванням онлайн лекцій, і нами було проведено статистичний аналіз з визначенням середнього балу для студентів, що відвідали різну кількість лекцій ($M \pm m$) та визначення кореляції за Пірсоном. Оцінка за модуль визначалася в кінці курсу і була в діапазоні від мінімальних 124 балів до 200 балів.

Результати та обговорення. Середній бал студентів за модуль склав $151,63 \pm 11,75$ ($n=65$). Для студентів, що відвідували всі лекції оцінка за модуль становила $152,82 \pm 12,48$ балів ($n=28$). Для студентів, що відвідували 60% та 80% лекцій оцінка складала $146,17 \pm 6,22$ ($n=6$) та $151,61 \pm 11,66$ ($n=31$) відповідно. Коефіцієнт кореляції за Пірсоном становив $r=0,12$ ($p=0,178$), що вказує на слабкий позитивний кореляційний зв'язок. Це свідчить про позитивний ефект від онлайн лекцій у навчальному процесі. Але з іншого боку, оскільки нулева гіпотеза не може бути відхилена, це вказує, що використання тільки компонентів перевернутого класу може забезпечити високий рівень навчання і дозволяє студентам підготуватися до практичних занять належним чином.

Висновки. Застосування компонентів оберненого класу, як частина загальноприйнятого навчального підходу, може покращити навчальний процес медичних студентів і може бути застосована в комплексі згідно затвердженої навчальної робочої програми з травматології та ортопедії. Перспективними є проведення досліджень з залученням більшої кількості студентів та вивчення впливу кожного окремого фактора, як класичної системи навчання так і технології оберненого класу на кінцевий рівень знань студентів з травматології та ортопедії.

Ключові слова: перевернутий клас, навчальний процес, якість освіти, травматологія, ортопедія, професійні навички, військовий стан.

Actuality. Due to the war period the education in Ukraine is facing many challenges that have negative effect on students' learning, such as: decreased funding of the Universities, loss of professors due to high migration, destruction of the Universities' infrastructure. The lower student number and their motivation have general negative effect on high schools' education [1]. Daily blackouts, public transport complications, air raid alarms – all these factors leave less time for education and invoke mental distress in students and University staff, requiring more attention to mental health and motivation [2]. Therefore any teaching approach to improve students' education process on Traumatology and Orthopedics is welcome, and if the positive effect of these measures is significant they are implemented during classes. The flipped classroom teaching approach is considered to be more effective than previous classical approach for professional medical education [3]. So we decided to perform the review of latest publications on this topic and then compare them with the actual educational processes in our department, developing the suggestions for further improvements.

Analysis of recent research and publications. We have found several publications showing the benefits of flipped education approach in several fields of medical education from nursing training [4, 5] and undergraduate dental education to clinical skills training in Orthopaedics [6]. The studies were analyzing students' satisfaction, quality of educational resources, students' academic scores to determine the importance of different factors on educational process. There are some peculiarities in medical students' education, as it consists of theoretical knowledge that should be obtained first, following with practical skills training. It was highlighted that previous reading and understanding of educational material at home before the class will better engage students in learning process, so students will use the class time in deeper level - for analyzing, evaluating, and application of the basic information and practical skills training [7]. That is even more important for such practice oriented subjects as Traumatology and Orthopaedics. Another research was hold to determine the effect of flipped education for postgraduate Orthopaedics students [8]. Its positive results were

significant mainly in clinical areas: imaging analysis, fracture classification, selecting correct treatment options for primary treatment and postoperative complications, but for learning basic theoretical knowledge there were no significant improvement.

There are many factors that influence the quality of education. The process of improvement should be applied in such way that creates the optimal conditions for students learning before, during and after the class. One of the most important factors considered by many authors is motivation [9, 10]. So the proper choice of the factors that improve motivation can be applied individually for every student or on a group of students [11]. Also avoiding or diminishing the effect of stress factor can improve students' motivation [12]. Some authors demonstrate the positive effect on students' learning process by applying such modern techniques, as virtual reality [13] and simulation games [14]. One of the novel techniques, particularly for clinical oriented medical subjects, is based on virtual patients with different injuries and diseases [15, 16], that helps to develop clinical thinking, diagnostics and correct management. Creating educational video is time and cost demanding process, but it was proved to be very favorable among students [17]. These and other factors, theories and techniques were analyzed by us striving to improve the quality of education and to chose correct components of flipped education that will improve motivation [18].

Highlighting previously unresolved parts of the problem overall. In the reviewed publications many researchers are discussing which factors would have better effect on the students' motivation and build their competency [19]. Also discussable is the question which of these factors can be better applied in flipped classroom on the regular basis [20]. The effectiveness of flipped education is also under continuous research, the process of assessment for different components of flipped education is still going on [21]. So for learning process on Traumatology and Orthopaedics the effectiveness of various components of flipped education remains unknown.

In the undertaken study we decided to compare the classical approach of delivering lectures to students, which is complicated with safety measures during war period, with implementing those components of flipped education that can be provided

via asynchronous online access. For these purpose video records of our lectures were created and uploaded on distant education website. The effectiveness of such approach was unknown, so to study it we undertake several strategies. First we created tests for self-assessment of students' knowledge that were given to student either at the end of online lecture or after watching the video record of a lecture. Also we assessed the students' knowledge during practical classes via discussion of a topic and clinical cases. Finally the recent study was undertaken to check the effect of online lectures on final module score on Traumatology and Orthopedics and to reveal if the components of flipped education were powerful enough to replace the classical way of education. Therefore we hope that our study has a potential to impact the implementation of flipped education in Traumatology and Orthopaedics learning process.

Formulation of the goals of the article. The staff of our University in daily teaching is focused on the quality of knowledge. Classical way of education is generally accepted, as giving lectures, holding practical and seminar classes have proved its effectiveness for many decades. But during war period the situation has changed. Also technological process offers new possibilities and new ways of education. Flipped education approach is considered to be an optimal way of teaching, with high involvement students in theoretical and clinical skills training, though the effectiveness of many components of flipped education should be assessed during daily practice. So, in our study we decided to assess the difference between the quality of the flipped education learning process alone and in combination with attending lectures by online access, as it is required according to safety measures in high educational institutions around Ukraine.

The aim of the study was to assess the educational process on the Traumatology and Orthopaedics, to analyze the different types of students' learning activity comparing flipped education alone and in combination with attending lectures via online access and searching the way of implementation new components of flipped education.



Materials and methods. The relation between final module score on Traumatology and Orthopaedics and number of attended online lectures were assessed for English speaking students (n=65) involved in this retrospective study. The components of flipped education were available for all students. The educational materials – methodical instructions, prerecorded lecture, and tests for self-control were accessible for all students on distant learning website of our University before every practical class. So attending online lectures was the only difference between students. Statistical analysis was performed to calculate average final scores for students with different number of attended lectures ($M \pm m$) and Pearson correlation coefficient between these variables. The final Module score was assessed at the end of the course with the minimum pass score of 124 and maximum of 200.

Results and discussion. The final Module score is the best indicator for student's level of knowledge after finishing the educational course. It may be influenced by many factors and to study the effect of any of them all other factors should be remained unchanged. So in our study the percentage of attended lectures was the variable that was under investigation. The correlation between this variable and final module score on Traumatology and Orthopaedics was studied.

The average students' final Module score was 151.63 ± 11.75 (n=65). For students that have attended all lectures the score was 152.82 ± 12.48 (n=28). For students that attended 60% and 80% of lectures the score was 146.17 ± 6.22 (n=6) and 151.61 ± 11.66 (n=31) respectively. Pearson correlation coefficient between amount of attended lectures and students' final score was $r=0.12$ ($p=0.178$), that means weak positive correlation. It indicates the positive effect of online lectures in educational process. Our work hypothesis was that online lectures alone effect on the final students' score. So the null hypothesis that there is no correlation can't be rejected due to the lack of statistical power ($p > 0.05$). Therefore we should state that just online components of flipped education can provide high educational level and allow students to be well prepared for practical classes. To explain the results of the study we should note that the positive effect of online lectures is present, as it gives students additional

options for asking questions and discussions about the most complicated points during the lecture. Another factor that may affect the study results is the fact that the students with high average score are attending lectures better, so it may be considered, as a weak point of our retrospective study.

There were also other components of flipped classroom that students used during the course. Some of them preferred reading educational material, others were watching video files with prerecorded lectures, and others were using both techniques before the class. The lecture records were uploaded on personal “Trauma and Orth” YouTube channel and the links were placed at the distant learning University website <https://eosvita.bsmu.edu.ua/>. The statistics on “Trauma and Orth” YouTube channel for last 4 years shows 25580 views. It was not feasible to track every student’s activity, but it was possible to check the total amount of views – 5390 during the course and calculate views per student ratio - 84.22. There were two types of videos – full lecture records, which were usually divided on two files per 45 minutes each; those gave students general information about lecture topic. Another type of videos – shot 5-10 minutes videos, that were covering gaps in knowledge. The latter are continuously developing and placed on demand.

The idea to use the video materials for educational purposes in medicine is not new. It showed positive effect in various medical fields, as pharmacology and ophthalmology [22, 23]. In those studies the effectiveness of flipped educational components were compared with the classical lecture based approach. But in available literature we haven’t found any study where both flipped educational components and online lectures are accessible for students on their choice, and the correlation between those approaches and final module score is studied. Kumar et al. (2024) made a study of the video lectures effect on the UK undergraduate students’ practical skills for trauma management and revealed from 66.3% to 87.7% of the positive feedback from students about different aspects of education [24]. Also there was the significant improvement in knowledge from pre-session to post-session and students who had completed the whole course were more confident performing trauma-based cases

during Objective Structured Clinical Examination. So the implementation of various components of flipped education, particularly based on new technologies, as video lectures, controlled by online tests for students' self-assessment can provide students with a high knowledge level before the class and makes clinical and practical skills training more effective, but it requires to held further research.

Conclusion. The study showed that adding components of flipped education to the previously used teaching approach is improving educational process for medical students and can be used within the approved educational program during Traumatology and Orthopaedics course. We consider the further studies are perspective involving more students and assessing the influence of each factor of both classical and flipped educational approach in final students score on traumatology and orthopaedics. The modification of teaching activity is required for practical classes, seminars and lectures. It gives more time for students to take part in practical skills training. Though for teachers it requires more time and efforts, for students such activity is more beneficial, both for theoretical and practical training. It creates more comfortable conditions for learning, increasing students learning motivation and results in better academic score.

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