UNIVERSITY OF VETERINARY MEDICINE BUDAPEST

Department and Clinic of Internal Medicine

Evaluating self-assisted learning using the VIN virtual clinics electrocardiography interpretation module

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1. Introduction

The COVID-19 pandemic presented several challenges for people all over the world, most severely affecting students. As a result of the pandemic many universities had to transition their courses to online classes. Colleges and universities were obliged move away from in-person training and keep students away from the institutions because of the following adoption of social distancing (i.e., increasing the physical space between individuals).(Rajab et al., 2020)

The rapid advancement of communication and information technologies has had an influence on educational delivery and quality. In some university courses throughout the world, virtual classrooms and teachers have taken the role of traditional in person education. Because of its flexibility, ease, and low cost, the majority of students have embraced this unique method of education. (Mahdy, 2020)

Although ECG interpretation is a practical ability, it does not always require live animals or physical touch to be properly taught - multiple publications have demonstrated that this skill may be efficiently transferred using recorded and generated materials.(Crawford & Doherty, 2012)

Auscultating heart sounds, rhythm, and the existence and strength of murmurs appears to be acquired early in a veterinary clinician's education. Murmur duration, particularly in case of loud systolic murmurs, is regularly underestimated, and this problem affects students, practitioners, and diplomates alike. In a study by (Naylor et al., 2001), diplomates, practitioners, and undergraduates, respectively, made the accurate diagnosis 53, 33, and 29 percent of the time. This shows that diagnostic ability was directly associated with the participants' level of training. After recognizing that the arrhythmia exists it is important with further assessment. This is done using an electrocardiogram. With this the clinical significance of the arrhythmia can be determined and next steps in management and if necessary treatment of the arrhythmia can be decided.(Mirvis & Goldberger, 2001)

Electrocardiography has been one of the most extensively available and utilized examinations since its introduction into clinical practice. Practitioners and those interested in sectors such as sport and exercise record ECGs in a variety of contexts.(Crawford & Doherty, 2012) Electrocardiography offers little opportunities for participatory learning, especially at the postgraduate level. The electronic learning methods are increasingly

popular in medical education, and numerous tools have been produced to help professionals enhance their abilities. (Nathanson et al., 2001)

The aim of this study is to evaluate a new teaching tool for electrocardiography interpretation. We will use a teaching tool launched at the VIN (Veterinary Information Network) platform.

The VIN (Veterinary Information Network) Virtual Clinic is proving to be a useful teaching tool for veterinary students worldwide.(Corbett, 2013) The use of modern technological technologies to boost student engagement and to improve their education is a current and pressing topic. Especially, there has been a lot of interest in the use of serious gaming in education because they are a popular recreational activity for many young students, which demonstrates their motivational, if not educational, capacity.(Molins-Ruano et al., 2014)

Providing good online tools for teaching more practical courses is growing to be more and more important. A significant part of veterinary and medical curriculum consists of hands on training which is best taught in person, but for the subjects that are possible to transition to an online environment it is important to make interactive tools that engage the students. In veterinary medicine, distance learning is viewed as a supplementary and successful means of delivering knowledge rather than a replacement for the conventional classroom. As a result, combining online learning with traditional teaching approaches is advocated. (Mahdy, 2020)

2. Literature review

3.1 Introduction of online learning

Online learning may be described as a tool for making the teaching–learning process more student-centered, inventive, and adaptable. Learning experiences in synchronous or asynchronous situations using various devices (e.g., mobile phones, computers, etc.) with internet connection are referred to as online learning. Students can learn and engage with professors and other students from anywhere in these environments as long as they have access to internet.(Dhawan, 2020)

Students who partake in online or remote education are physically separated from their teachers and need a delivery system. (Wang, Shannon, & Ross, 2013; Wilde & Hsu, 2019). Technology mediates student-teacher interaction, and the design of learning environments (i.e., the space where learning takes place) may have a significant impact on learning outcomes.(Gonzalez et al., 2020; Wang et al., 2020) As online education expands, a research in the United States found that many educators are only now beginning to transition their face-to-face instruction to an online setting. (Rajab et al., 2020) Wikis, blogs, social media, mobile apps, virtual worlds, learning management systems, and other digital technologies are becoming more common in formal learning environments, especially in online learning environments like massive open online courses (MOOCs), and in many of these cases, technology is the means by which participants interact. (Bower, 2019) Successful online teaching is the product of meticulous instructional design and preparation, which has been studied for decades.(Hodges et al., 2020) The key argument in critical approaches to educational technology research is that technology is seen as occurring in a social setting, and such is affected by participants and environment, rather than being assumed to have fixed consequences.(Bower, 2019)

Online education is linked to a number of arguments. Some of the points associated to online pedagogy include accessibility, cost, flexibility, learning pedagogy, life-long learning, and policy. Online learning is believed to be simple to use and can even reach out to rural and isolated locations. It is seen as a significantly less expensive style of education due to

reduced transportation, lodging, and total costs of institution-based learning. (Dhawan, 2020)

There are also some age-related disparities in technology use and abilities, according to experts, resulting in a digital divide across generations. Young people who have grown up with computers and the internet are believed to have a natural affinity for technology and to be able to adjust to changes in the digital world with ease. Older generations are thought to be more challenged by technology, displaying less technical affinity and knowledge than their younger colleagues. In education, this digital divide would mean a significant divergence between pupils and teachers.(Waycott et al., 2010)

Another more appealing feature of online learning is the learner's ability to arrange or plan their time to complete online courses. Blended learning and flipped classrooms are created by combining face-to-face lectures with technology; this sort of learning environment can help students achieve their full potential. Students may learn whenever and wherever they want, gaining new skills and preparing for a lifetime of learning. In this fast-paced world, the government also understands the growing relevance of online learning.(Dhawan, 2020)

3.2 Advancement in online teaching

For decades, researchers have studied online education, particularly online teaching and learning. Online assessment, online teaching, and online course design are the subject of several academic reviews, hypotheses, models, requirements, and assessment criteria. According to (Hodges et al., 2020) , successful online learning is the product of meticulous instructional preparation and preparation, as well as the use of a formal design and development model. The consistency of the training is influenced by the design process and careful analysis of various design decisions. (Branch & Dousay, 2015)
A purely online university course typically takes six to nine months to design, prepare, and produce before it can be implemented in the curriculum. By the second or third iteration of their online courses, faculty are generally more comfortable teaching online.(Hodges et al., 2020)

One of the most extensive areas of study in online learning is on the different paths of interaction, which includes student–content, student–student, and student–learner. The result of these studies demonstrates that the presence of each of these forms of interaction improves learning outcomes when they are meaningfully integrated.(Hodges et al., 2020) As a result, thorough planning for online learning entails not just determining the information to cover, but also considering how you'll support the various sorts of interactions that are critical to the learning process. Learning is recognized as both a social and a cognitive process in this approach, rather than just a matter of information transmission.(Hodges et al., 2020)

Those who have developed online programs over the years can speak to the fact that good online learning aspires to be a learning community that helps learners not only academically but also socially. Considering how much infrastructure exists to support student achievement in face-to-face education: library resources, housing, career services, health services, and so on. Lecturing is not necessarily what makes face-to-face education so successful, the lectures are just one element of an entire ecosystem that is meant to provide formal, informal, and social resources to learners. Finally, effective online education necessitates an investment in a student support environment, which takes time to design and develop. Simple online material delivery can be quick and affordable compared to other choices, but equating it with full online education is similar to equating lectures with the whole of residential education. (Hodges et al., 2020)

In Norway, NMBU has created a writing center, which offers the students guidance in academic writing. The writing assistance gives the students all the feedback online, either on social media or on a school-based platform. The way this writing center is drifted was one of the grounds for William Warner winning Fronterprisen 2012 for LNG 240 – Academic writing.(*Årsrapport Om Studiekvalitet UMB 2012-2013*, n.d.) And proves that the use of online platforms in education can be very helpful and successful.

3.3 Changes due to covid-19

The COVID-19 pandemic brought with it several challenges for people all over the world, severely affecting those in education. As a result of the pandemic many universities had to transition their education online, as colleges and universities were obliged to empty their classrooms and keep students away from the institutions because of the following adoption of social distancing (i.e., increasing the physical space between individuals). (Rajab et al., 2020) Due to the challenges posed by the COVID-19 pandemic, colleges and universities were forced to decide the way to continue their education and studying while keeping their teachers, staff, and students safe from a rapidly spreading and little-known public health emergency. To help deter the transmission of the virus that causes COVID-19, several universities have decided to cancel all face-to-face lectures, including hands on training and other learning opportunities, and have requested that teachers transfer their courses online. (Ali, 2020; Hodges et al., 2020). Most schools have shifted to remote learning using the easiest and most convenient methods available, such as conferencing platforms, email, and phone calls. (Rajab et al., 2020).

Courses delivered digitally in response to a global health crisis or catastrophe are different from well-planned online learning opportunities. When considering this emergency remote education, colleges and universities working to preserve training during the COVID-19 pandemic were required to be aware of the challenges, such as disruptions to student, staff, and faculty lives(Hodges et al., 2020) Thus, instructors and administrators need to consider that students might not be able to attend to courses immediately. Flexibility with deadlines for assignments within courses, course policies, and institutional policies should be considered.(Hodges et al., 2020)

The primary difficulty of online education, according to the study by (Rajab et al., 2020), was communication. When transitioning to a virtual setting amid a healthcare crisis, faculty and students have rapidly learnt the need of clear and succinct feedback. This chance to increase communication between teachers and students during COVID-19 might also help communication in regular face-to-face classes.

Some analysts believe that the COVID-19 pandemic will have a beneficial influence, resulting in a greater embrace of online and technology-enabled education. There was already a lot of improvement and use of education technology before COVID-19. Online education, according to proponents, is just as efficient as traditional classroom education.(Rajab et al., 2020)

Despite studies showing the contrary, online learning has a reputation for being of lesser quality than face-to-face learning. This rushed online shift, due to the COVID-19 pandemic, by so many institutions at once may reinforce the impression of online learning as a poor choice, while in reality, no one transitioning to online teaching under these conditions will be able to fully exploit the affordances and potential of the online format.(Hodges et al., 2020)

Establishing an online learning environment is a pedagogical and instructional challenge as well as a technological one. Educators strive to help students become self-directed learners, but not all students exhibit the self-control abilities required for online learning. Students were forced to enter the online system without any preparation during the epidemic, and this study found that their motivation, self-efficacy, and cognitive engagement all dropped. As a result, it is critical to educate children about new technologies before they are implemented.(Patricia Aguilera-Hermida, 2020)

3.4 Benefits of online learning

Lecture based face-to-face learning has been the school model for many years. Moving teaching online will likely pose several challenges, and it will be important to weight benefits and disadvantages against each other as we move forward towards a more online based schooling system. The COVID-19 pandemic has pushed schools to make quick changes to online teaching to keep the students safe. But there are other advantages to online learning next to safe distancing.

When comparing students from the 19/20 academic year with students from the 20/21 academic year, students studying during COVID-19 with online learning performed significantly better than the previous year. (Gonzalez et al., 2020)
Students in online courses must be assured that they are following the course accurately without any prior context, and they must therefore strive continuously to avoid missing any relevant information. Another possible explanation is that they are concerned about failing the school year as a result of their COVID-19 restriction, so they try harder to solve any difficulties. Finally, students may be inspired by their inherent commitment in a troubling situation to do whatever possible to help fix the challenges that higher education faces.(Gonzalez et al., 2020)

The capacity for pupils to track their learning progress is an advantage of using online learning platforms. Students can select whether to change their involvement with the course content or to strengthen their learning efforts based on how far they have advanced in their learning. When everything is online and easily available students may, for example, compare how much they had learned early in the semester versus their progress as the semester progressed. This helps the students assess their standing and plan ahead, it gives great advantage to active students who are eager to learn more and make sure their studying is not in vain.(Hamid et al., 2015)

According to a study done by (Patricia Aguilera-Hermida, 2020) increased family time, personal growth, and new hobbies surfaced as three themes connected to positive elements or changes that students experienced after the stay-at-home order due to the COVID-19 pandemic. The ability to control their own study time gave the students new freedom to

enjoy life outside their studies as well. For many students the curriculum can seem overwhelming, but with teachers more available online, many students thrive.

A study by (Hamid et al., 2015) has showed that students perceive their levels of contact and likelihood of receiving feedback from their instructors personally to be significantly greater with online learning. This suggests that using online educational platforms gives students an alternative way to stay in touch with their instructors at all times, regardless of time or place. In conventional techniques of teaching and learning, online education fundamentally surpasses the physical limit as well as the "emotional barriers" that students may experience with their lecturers.

The usage of social technologies seems to make learning more enjoyable for many students, and to give a more comfortable kind of engagement for students who are reluctant to speak up in class. Many students who classify themselves as “introvert” find it a lot easier to speak up over social platforms then in a classroom. (Hamid et al., 2015) The students use technology to communicate with their friends and family on a personal level, and are already comfortable using it. The "fun" factor is presumably maintained by extending the usage of social technology familiar to students for online social networking to educational activities. This is a chance for educators to use familiar and entertaining social technology, to make online educational activities that makes learning interesting and engaging for students at all ages.(Hamid et al., 2015)

The student’s questions in the study by(Waycott et al., 2010) also pointed to communication benefits, convenience, obtaining access to information resources, no challenge because of distance, and offering opportunity to examine and modify learning materials as important benefits of utilizing technology to enhance their studies. The ability to ask questions on public discussion boards, which allowed the lecturer and other students to join in the dialogue, was one of the communication benefits mentioned.

(Mahdy, 2020) suggests to improve online education in general, it is recommended that platforms for online learning be provided, that students be provided with electronic devices to access the internet, that internet speed be improved, that cheaper or even free internet packages be provided during the pandemic, that lecturers be provided with professional training, and that student-teacher interaction be improved. Additionally, it is recommended

that virtual resources be provided to mimic laboratory work, that practical lessons be taught using interactive tools such as videos and 3D animation, and that accessible e-books and instructional videos be provided for practical lessons to improve online veterinary science education.

For the educational institutions online schooling also has several benefits. The utilization of virtual or online courses to share expertise among schools would further separate enrollment decisions from space availability and lower instructional expenses. Several institutions that use virtual classroom systems would pool instructor wages for specific subjects.(Willis et al., 2007)

3.5 Disadvantages of online learning

There are some concerns related to online assessment methods such as the opportunity for cheating by the students. However according to a study done in 2020, students achieved significant improvements in their scores even in tests that were performed in the online format in previous years.(Gonzalez et al., 2020) Time management, usage of digital tools, students' assessment, communication, and the loss of in-person connection are among the challenges of online education that have been described in the medical literature thus far. (Rajab et al., 2020)

Furthermore, online education may not be fair in terms of access or instructional quality. Some students lack access to laptop computers or high-speed internet at home. Instructors can be technophobic, which means they are afraid of or unsure how to cope with computer hardware and software in their classrooms. This can lead to subpar teaching, and time wasted spent on technological issues. During an emergency, challenges to the online environment may hinder the uptake of technology-enabled education. Also, for reasons such as technophobia, elderly internet users gain the least from online education.(Rajab et al., 2020)

Students' online assessments, access to computer hardware or software, and other technical hurdles, as well as a lack of prior experience with online education, pandemic-related fear, and technophobia, were all problems, mentioned by the participants in the study by (Rajab et al., 2020). These difficulties were similar to those encountered when switching to online schooling in non-emergency settings. Technophobia was the least mentioned problem in the current survey of highly educated participants. Technophobia, was shown to be linked to the level of education of the users. Identifying these issues may help us recognize online teaching and learning techniques that can improve classrooms even when we return to traditional training.

In online education, like in traditional education, engaging the student in the learning process is critical. The issue is to come up with acceptable engagement strategies for online education. It is critical that interaction be included in online learning. Course satisfaction is dependent on course interaction, according to research. Interaction is not guaranteed while using a computer. In fact, research suggests that the lack of connection between teacher and student is the major disadvantage students experience in online courses.(Jacobs, 2013).

A study done by (Patricia Aguilera-Hermida, 2020) showed that students who favored face-to-face instruction found it difficult to adjust to online instruction. There was a fairly significant association between preference for face-to-face learning and difficulty adapting to online learning, according to the responses.

According to (Jacobs, 2013), the favorable opinions of the students in the course grow as the amount of interaction in the course increases. The engagement should allow the learner to engage in conversations with other students while also receiving feedback from the instructor. Instructor feedback reinforces course information and encourages students to participate more actively in the learning process.

Many instructors struggle to get an appropriate level of interaction with their students during online classes, and the importance of proper interaction can often be overlooked. This is not only important for the participants satisfaction with the course. It is also necessary in order to keep the student engaged in the course. Students in conventional classes receive face-to-face interaction, which reinforces and motivates them to stay on target and finish tasks. This isn't the case in online classes. According to studies, the processes essential for learning and information retention take place in conversations. (Jacobs, 2013) Computer-assisted learning frequently lacks the social contact required for the formation of these crucial conversations. It is the instructor's responsibility to use the computer creatively to provide ongoing contact with all course participants. Not only interaction between instructor and student is crucial for learning, often the interaction among students can lead to new discoveries and answer to questions not thought to ask conversations. It is the instructor's responsibility to use the computer creatively to provide ongoing contact with all course participants.(Jacobs, 2013)

After the hasty switch to online learning due to COVID-19, students reported a reduction in four of the five following abilities: capacity to finish assignments on time, ability to succeed in classes, ability to discuss issues with classmates and/or instructors, and time management skills. Only one factor, understanding of new learning tools (analyzing/creating films, online quizzes, and so on), was perceived to have improved.(Patricia Aguilera-Hermida, 2020)

3.6 Online learning in veterinary medicine

As time becomes even more valuable due to rising demands, health care practitioners must not only acquire a wider range of educational material, but also do so more quickly. In comparison to traditional teaching approaches, computer-assisted training has been proved to be not only an effective learning tool, but also to take less time to reach the same level of competency.(Nathanson et al., 2001)

The veterinary profession was originally taught in traditional learning styles, with old-school classrooms and face-to-face teaching. The COVID-19 pandemic has brought on a sudden onset of challenges for schools all over the world, but even more so for practical educations like veterinary medicine. Within the field of veterinary medicine there is a continuous need for information flow between veterinarians in practice, researchers, teacher and students. The exchange of new knowledge, emerging diseases, new treatments and unusual cases is important for the development of the profession.(Koch et al., 2012)

A study done by (Koch et al., 2012), where the participants were either practicing veterinarians or veterinary students, showed that 78.4% of the students found E-learning effective 94.6% used internet for communication, and all of the participants had access to a computer and internet.

Internet-based online training has the potential to become an important part of the educational process for veterinary students. Hands-on experience is still critical to obtaining a DVM degree and proper practical skills, but in combination with online tools we can even further expand the knowledge of veterinarians. Virtual training might also play a significant role in offering lifetime education to preserve competence and augment a professional decision to transition career field. Distance education, both nationally and internationally, would also allow for the most effective use of unique abilities in specific areas of professional specialization.(Willis et al., 2007)

3.7 Electrocardiography

In the medical profession, the importance of ECG in the investigation of heart physiology and anomalies is significant. Signal processing techniques are developed and utilized to analyze ECG signals in order to diagnose heart diseases.(Appathurai et al., 2019) The ECG was the first and most widely utilized bioelectric signal to be computerized, as well as the most widely used heart diagnostic test.(Mirvis & Goldberger, 2001)

The electrocardiogram (ECG) is the result of a complicated sequence of physiologic and technological processes. Ion fluxes across cell membranes and between neighboring cells first form transmembrane ionic currents. These currents are coordinated by cardiac activation and recovery phases to produce a varying cardiac electrical field in and around the heart during the cardiac cycle. This electrical field is perturbed by a number of different tissues, including the lungs, blood, and skeletal muscle. Electrodes, which are put in precise positions on the extremities and torso are configured to create leads detect the currents reaching the skin. To create an electrocardiographic recording, the outputs of these leads are amplified, filtered, and presented by a number of equipment. These signals are digitized, stored, and analyzed by pattern recognition software in case of computerized systems. The diagnostic criteria are then used to create an interpretation, which can be done manually or with the help of a computer. (Mirvis & Goldberger, 2001)

Finally, the electrocardiographic tracings are compared to numerous diagnostic criteria in order to discover particular anomalies. Electrocardiographic criteria are often developed from physiologic constructs and are used as the sole basis for a diagnosis with no anatomic or physiologic link. For example, the electrocardiographic criteria for intraventricular conduction abnormalities are diagnostic even when there is no anatomic reference point.(Mirvis & Goldberger, 2001)

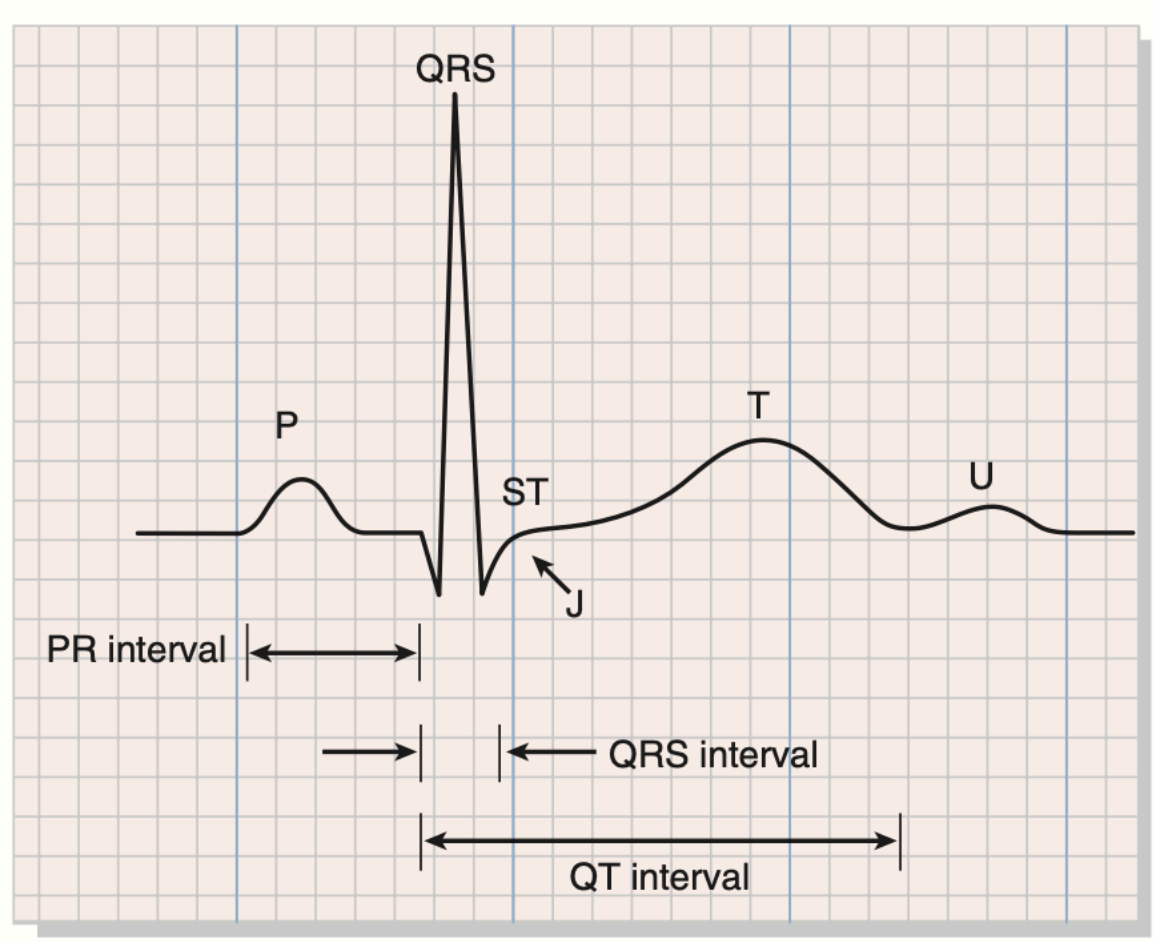

Figure 1- The waves and intervals of a normal electrocardiogram. *(From Goldberger AL: Clinical Electrocardiography: A Simplified Approach. 7th ed. St. Louis, CV Mosby, 2006.)*

The electrical activity of the heart is represented by an electrocardiogram (ECG). The ECG is made up of five waves: P, Q, R, S, and T as shown in **figure 1.** In a normal interaction, electrodes places on the body (human or animal) might measure this signal. Signals from these electrodes are routed through amplifiers and analogue-to-digital converters to basic electrical circuits.(Parak & Havlik, 2011)

The P wave represents atria depolarization. From the SA node, atrial depolarization extends to the left atrium. The PR interval is the distance between the start of the P wave and the start of the QRS complex. The time it takes for an electrical impulse to go from the sinus node to the AV node is reflected in this interval. The rapid depolarization of the right and left ventricles is represented by the QRS complex. Because the ventricles have a lot of muscle mass, the QRS complex has a lot more amplitude than the P wave. The ST segment is the link between the QRS complex and the T wave, and it occurs when the ventricles are

depolarized (during systole). The repolarization of the ventricles is represented by the T wave. (Goldberger, 2007)

ECG leads record the difference in potentials between two electrodes, whereas electrodes are the places where an electrical potential is detected. With one electrode linked to the positive pole and the other to the negative pole of the voltmeter, each bipolar lead detects the difference in potential between electrodes at two extremities(Goldberger, 2007):

Lead I captures the difference in voltage between the electrode on the left arm (the positive pole) and the electrode on the right arm (the negative pole).

The difference between electrodes on the left leg (positive) and the right arm (negative) is recorded by Lead II.

The difference between electrodes on the left leg (positive) and the left arm (negative) is recorded by Lead III.

A fourth grounding electrode is optional.

The connections of the leads on a dog can be seen in **figure 2.** Together with a normal ECG recording. ECGs are normally recorded on a grid or a graph.

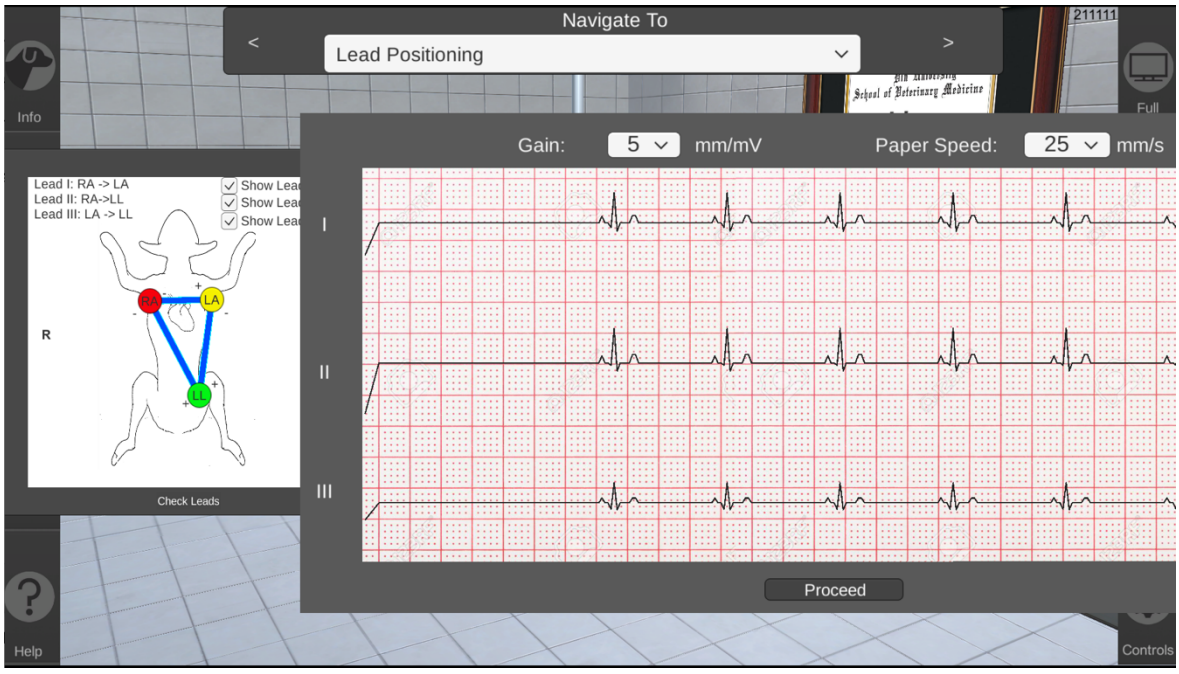

Figure 2 – connection of the leads in a dog, and a normal ECG reading. Picture is collected from the VIN virtual clinic.

The electrocardiogram (ECG) monitors the electrical activity of the heart; the signal amplitude is modest, ranging between 0.4 and 3 mv. The modest amplitude of the ECG emphasizes the significance of using an adequate filtering strategy before proceeding with biological analysis. Surface electrodes (Ag/AgCl) are often employed for ECG signal capture, and three lead configurations are available: bipolar, unipolar, and augmented unipolar. Baseline wander (also known as low frequency noise), power line interference, muscle noise, and electro-magnetic interference from other equipment are all sources of noise in ECG readings. ECG signals have a frequency range of 0.5 to 100 Hz, and artifacts play a significant part in their processing. The letters P, Q, R, S, and T are commonly used to represent the ECG signal. The low frequency components are represented by P and T, whereas the high frequency components are represented by the QRS complex. The major cause of power line interference (PLI) in ECG and equipment connection wires is EMI. PLI is also caused by variations in electrode impedance and stray current across the cables and equipment, which degrades the signal and alters the minute characteristics in the signal.(Appathurai et al., 2019)

Changes in the normal ECG patter occurs in numerous cardiac abnormalities, including cardiac rhythm disturbances like atrial fibrillation and ventricular tachycardia, cardiac chambers enlargement, and electrolyte disturbances such as hypokalemia and hyperkalemia.(Mirvis & Goldberger, 2001)

2.7.1 Teaching ECG

For medical students, veterinarians, and doctors, the ability to interpret electrocardiograms (ECGs) is an important day one competence. However, there are limited resources available to build and improve the requisite high degree of "ECG literacy." The importance of having a high degree of ECG interpreting expertise is growing. Advances in the management of acute myocardial infarction, for example, have made correct diagnosis and triage critical.(Ector et al., 2000) Unfortunately, most medical and veterinary school curriculum do not devote enough time to teaching electrocardiography, and house staff exposure to ECG interpretation is generally sporadic.(Nathanson et al., 2001)

The ECG's value has grown as a result of recent advancements. Several cardiac abnormalities alter the normal ECG pattern, including atrial fibrillation and ventricular tachycardia, cardiac chamber enlargement, and electrolyte imbalances such as hypokalemia and hyperkalemia. It's also a crucial test for determining the presence and severity of acute myocardial ischemia, locating the source and pathways of tachyarrhythmias, evaluating therapeutic options for patients with heart failure, and identifying and evaluating patients with genetic diseases who are at risk for arrhythmias.(Mirvis & Goldberger, 2001)

ECGs and their proper interpretation are problematic for many health practitioners. A study done by (Palmer et al., n.d.) found that the individuals' performance did not increase over an eight-week period whether they seek to do so just by typical clinical experience or non-structured self-education utilizing textbooks and customary resources. It did however show that the CD-ROM-based ECG lesson and self-assessment tool created at their department was found to be effective in imparting knowledge of electrocardiography theory and improving abilities in ECG interpretation. In the study, this computer-based package was more successful than traditional lessons in both dimensions. This conclusion is in line with prior research that has found that specified self-education is more effective than lessons in enhancing health workers' ECG knowledge.

3. Objectives/Questions

The objective of this study was to evaluate the impact of exposure to the ECG interpretation module of the VIN virtual clinic on the student's ability to understand the basics of electrocardiography.

Figure 3 - VIN virtual clinic ECG tool

4. Materials and Methods

5.1 Student population

34 students from the University of Veterinary Medicine Budapest (UNIVET) participated in this study. Students were recruited on a voluntary basis, and were spread among the 7th, 9th and 11th semester, one student from 5th semester also participated. All the students except one had completed the third-year subject "Clinical Diagnostics, in accordance with the curriculum of the university. This subject includes lectures and practicals on physical examination of the cardiovascular system, as well as the basics of electrocardiography.
To maintain anonymity while tracking group-based and individual development, each student submitted a nickname for the project.
The participants were assigned into three groups at random (using the random number function in Microsoft Excel and organizing them according to value). The groups were divided in two study groups (n=11 each) and a control group (n=12). The control group was decided to be largest, as we anticipated the highest drop off from this group.

5.2 Pre- and post-training tests

Each group underwent a pre- and post-training test within a four-week interval. Both tests consisted of the same 10 multiple-choice questions, with four alternative answers for each question, in addition each question had an "I don't know option". The questions were in variable difficulty degree. The students scored 1 point for each correct answer.
The questions were presented to students in the same order on the pre- and post-tests. Students were not given comments on their performance after the pretest.

Despite the fact that students took both examinations at home, no real measurements were implemented to prevent cheating other than advising students not to cheat during the briefing session because it would serve no purpose other than to falsify the results. To accommodate their various schedules, students were given a full day to complete the test on both occasions.

The first group of students undergoing self-study (n=11) were asked to spend a minimum of 1 hour on the VIN virtual clinic tool to play an interactive game about the basics of ECG interpretation.
The second group of students (n=11) participated in a one-hour webinar by a senior lecturer about ECG, it was also possible for the students who could not attend live, to watch a recording of the lecture afterwards.
The third group of students (n=12) served as a control group. Between the pre- and post-training examinations, these students received no training, thus they had to depend on their knowledge of the content taught during the "Clinical Diagnostics" course, which was part of their normal didactic curriculum.

Each student in the self-study group had to indicate how much time they spent on the training website prior to the post-training exam. Students who were assigned to the webinar session were asked if they attended the webinar, watched the recording afterward, or did neither. Dropout was tracked in all groups; students who just took the pre-training exam or did not spend enough time with the materials supplied for their group were discarded from the research. According to these conditions, one student was removed from the self-study group after failing to complete the post-training exam, making the final number of students 10 in this group. 4 students were removed from the webinar group, 3 did not watch the lecture or recording, 1 did not participate in the post-intervention exam, making the final number of students 7 in this group. No student was removed from the control group as they all finished both pre and post-training exams.

5.3 Statistical methods

To ensure that the three groups of students were similarly trained prior to the trainings, we first compared the pre-training test scores for the first and second question between the three groups using a Kruskal-Wallis test, with Dunn's Post-hoc testing when appropriate.
To detect a training effect, we then compared differences in the pre- and post-training scores between the three groups using a Kruskal-Wallis test with Dunn's post-hoc testing where appropriate.
We also examined the pre- and post-training scores for the first question for each group separately using a Wilcoxon Signed Ranks test. Significance was established at $p<0.05$.

5. Results

There was a drop-off of 1 student in the self-study group, 4 students in the webinar group, and 0 students in the control group.

The pre-training scores did not differ between the groups (P=0.83584). The post-training scores however showed significant difference (P=0.00782).

When analyzing the pre and post-training differences within each group, the self-study group's W-value was 1. The critical value for W at N=9 was 5 for a p of 0.05, therefore the result was determined significant. For the webinar and the control group, we could show no significant differences between the pre- and post-training tests. (with W values of 5.5 and 15.5 and critical W values of 3 and 5 respectively).

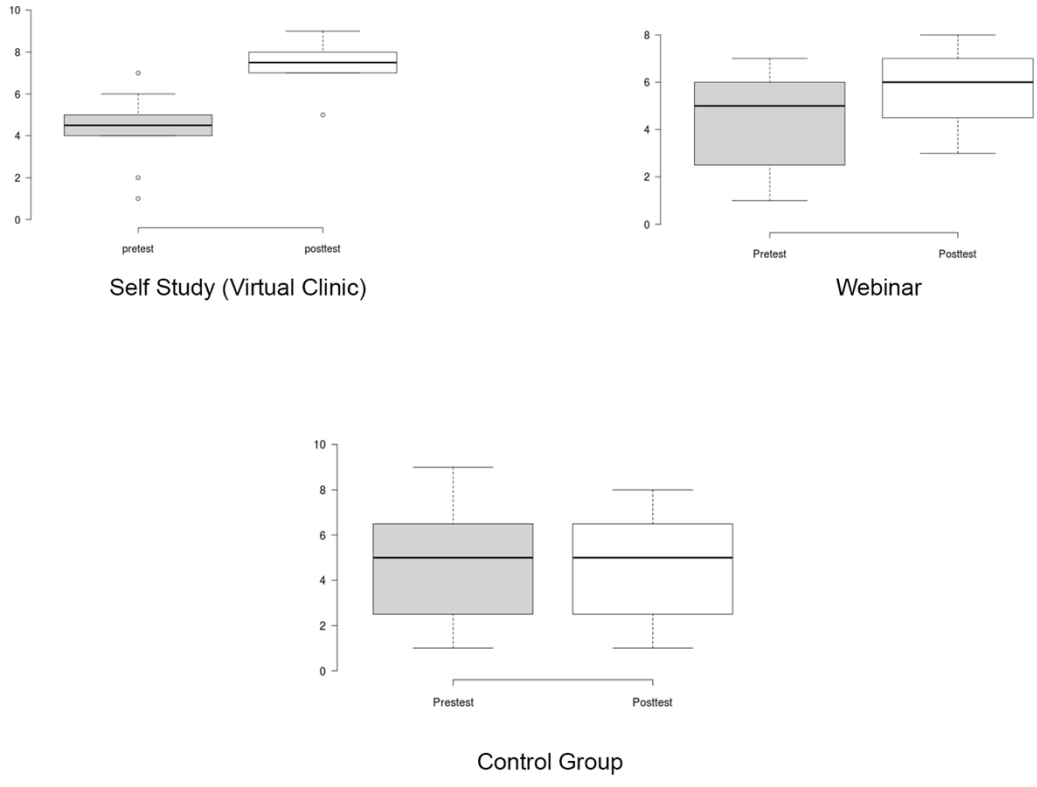

Figure 4 – Pre- and post-training test performance of each group is represented in this figure.

Pre- and post-training test performance of each group is presented on **Figure 4**.

Individual pre- and post-training test scores of the self-study, the webinar and the control groups are presented on **figures 5.**

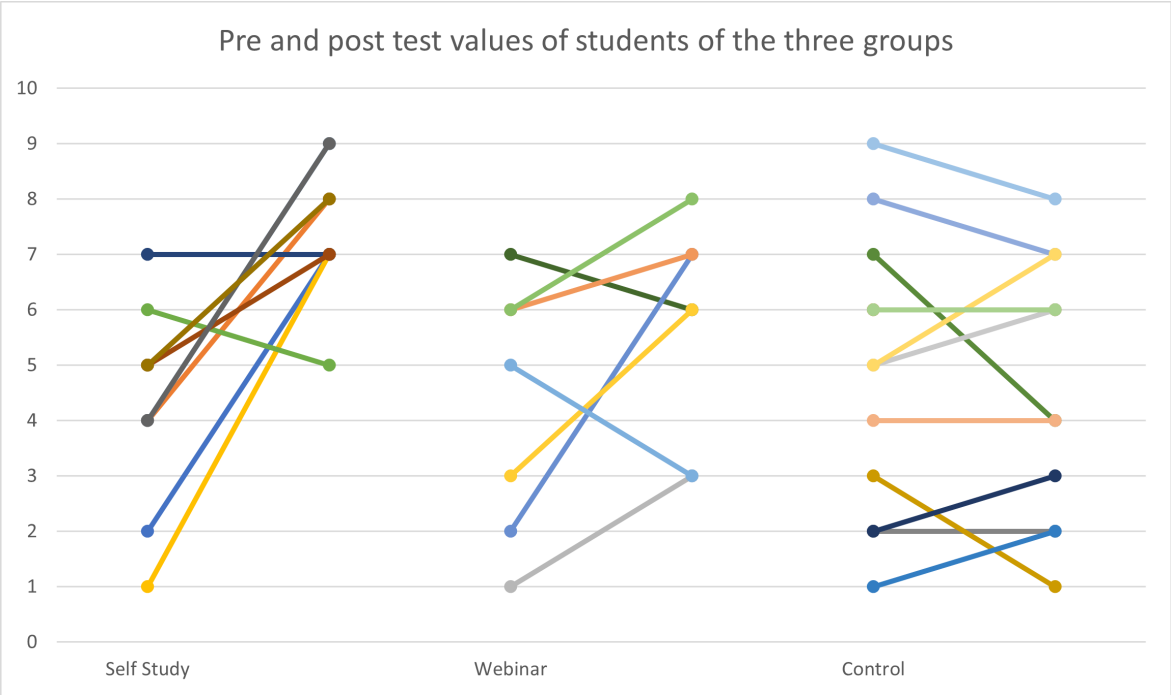

Figure 5 - Individual pre- and post-training test scores of the self-study, the webinar and the control groups are presented

6. Discussion/Conclusions

Online learning faces several challenges, but also offer great opportunities for students worldwide to connect and learn. As the world moved more towards a digital lifestyle it is natural for education to follow and in order to accommodate the changing needs of students. (Starr & Murray, 2005) These challenges and opportunities must be carefully assessed to give students the best possible educational outcome.

Our results suggested that remote online training of ECG using the VIN virtual clinic tool improves the understanding of veterinary students of the basics of ECGs.
The pre-training test revealed no differences between the three groups of students, despite being recruited from various years of training. This supports the claim that the participating students had similar understanding or skill levels at the start of the research.

Only the self-study group, who used the VIN virtual clinic tool, showed significant improvement between the pre and post-training tests.

Even though the webinar group showed a slight improvement after the lecture, it was not enough to be significant. This does not prove conventional teaching to be inferior, as it might be caused by a number of factors. The webinar groups, for example, would not be able to improve as much as the other group if their pre-training scores were higher. Our baseline study, however, contradicted this notion, as all three groups had similar beginning scores. A more likely explanation is that our sample size was insufficient to identify a significant difference within the webinar group, as the drop off rate was highest in this group.

The inability of the control group to increase their test performance, on the other hand, implies that they did not get effective extra training over the four weeks between tests.
This may also point to the students not cheating or accessing any additional information between tests.

The combined impact of the two educational methods has been assessed in previous investigations. Due to the limited number of participants, we were unable to incorporate a fourth student group. As a result, it's unclear if educating students within both self-study and

webinar training could help them enhance their ECG interpretation, and proves to be an important limitation to our study.

Another limitation was the absence of self-assessment in the self-study materials, which may have improved the efficacy of this teaching strategy.
The fact that no qualitative feedback from students was obtained as also a limitation of our study, as this would have offered useful information on the students' perceptions of the teaching approaches under consideration, as well as any possible problems that may have influenced learning results.

Finally, it is important to note, that students were not asked to evaluate actual ECG tracings during this study, so the ability of students to utilize the measured improvement in theoretical test scores in practice remains to be seen.

The aim of this study was to evaluate the impact of exposure to the ECG interpretation module of the VIN virtual clinic on the student’s ability to interpret ECG.
In conclusion, the results of our study showed a significant improvement in the test scores of the students who participated in the self-study group and got to test the VIN virtual clinic tool. Our student pool was limited, but from what we can see the VIN virtual clinic did work as an education tool to help the students better understand the basics of ECG.

Our findings imply that instructors should explore establishing virtual veterinary patients, similar to how virtual patients were used as a delivery mechanism for comparable recordings in human medicine, where students' understanding of cardiology improved significantly.

The result of this study points towards online self-studying being both motivating and educational for student. We should continue to use digital media to create content that engage and educate tomorrows students.

7. Summary

Veterinary students have little opportunity for learning electrocardiography in a participatory way, especially at the postgraduate level. The electronic media is increasingly being used in medical education, and numerous tools have been produced to help professionals enhance their abilities. (Nathanson et al., 2001)

The aim of this study is to evaluate a new teaching tool for electrocardiography interpretation. The tool will be an online learning tool published at the VIN (veterinary information network) virtual clinic available to veterinarians and veterinary students worldwide. The goal is to be able to increase the average knowledge among clinicians about the basics of ECG and ECG interpretation, for an earlier and better assessment of cardiac diseases.

Recent publications on online learning show that more and more schools and students are seeing the benefits of implementing online educational form into their curriculum. This transition is not fully completed yet, but students seem to be positive and motivated by implementing different educational models into their studies.

During our study thirty-four voluntary veterinary students did and online pre-test about basics ECGs knowledge. They were assigned randomly to three different groups, one self-study group (n=11), one webinar group (n=11) and one control group (n=12). The self-study group got to test the VIN virtual clinic interactive module, the webinar group watched an online lecture on electrocardiography done by a senior lecturer. The control group received no training between the pre- and post-training test.

In the pre- and post-training test scores, only the self-study group showed improvement determined significant. The control group showed no improvement and the webinar groups improvement was not enough to be deemed significant.

The results of our study suggested that the VIN virtual clinic interactive module was an adequate learning tool, students scored significantly better on their post-training tests, and the drop off rate was low.

Further study with an increased sample size would be recommended to better see the improvement provided by webinars. Also adding a fourth group of students receiving training with both the webinar and VIN virtual clinic interactive module could be interesting.

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