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Original Article

A qualitative study on negative attitude toward electrocardiogram learning among undergraduate medical students

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Abstract

Objective: Negative affect state toward learning has a substantial impact on the learning process, academic performance, and practice of a particular subject, but such attitude toward electrocardiogram (ECG) learning has still received relatively little attention in medical education research. In spite of the significant emphasis in investigating ECG teaching method, the educators would not be able to address ECG incompetency without understanding the negative perception and attitude toward ECG learning. The purpose of this study was to assess the undergraduate students' difficulties in ECG learning and hence help educators design appropriate ECG learning curriculum to instill competent skill in ECG interpretation based on this outcome. **Materials and Methods:** A total of 324 undergraduate preclinical (year 2) and clinical (year 3–5) medical students participated in this study. The research design used thematic analysis of an open-ended questionnaire to analyze the qualitative data. **Results:** The thematic analysis detected five major emergent themes: lack of remembering (18.2%), lack of understanding (28.4%), difficulty in applying (3.6%), difficulty in analysis (15.1%), and difficulty in interpretation (17.8%), of which addressing these challenges could be taken as a foundation step upon which medical educators put an emphasis on in order to improve ECG teaching and learning. **Conclusion:** Negative attitude toward ECG learning poses a serious threat to acquire competency in ECG interpretation skill. The concept of student's memorizing ECG is not a correct approach; instead, understanding the concept and vector analysis is an elementary key for mastering ECG interpretation skill. The finding of this study sheds light into a better understanding of medical students' deficient points of ECG learning in parallel with taxonomy of cognitive domain and enables the medical teachers to come up with effective and innovative strategies for innovative ECG learning in an undergraduate medical curriculum.

Keywords: *Electrocardiogram learning, Medical students, Negative attitude, Perceived difficulties, Thematic analysis*

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Introduction

Electrocardiogram (ECG) is one of the most common, useful noninvasive diagnostic bedside procedures in clinical practice [1-3]. Misinterpretation of an ECG can lead to morbidity and mortality, especially in the realms of myocardial infarction, heart block, and arrhythmias [4,5]. Despite the importance of correct ECG interpretation in clinical management [6,7], suboptimal ECG competence was found in medicine residences of various specialties, all of which were supposed to have core skill of daily ECG practice [4,8-10]. Little *et al.* pointed out that it might be necessary to incorporate formal ECG training and assessment into the undergraduate curriculum, as this improved diagnostic accuracy [11]. Nowadays, ECG interpretation is, therefore, regarded as a crucial learning outcome in undergraduate curricula [10,11].

Despite ECG interpretation being taught since the 1st year of medical school, several studies have shown that medical students demonstrated lack of confidence and poor ECG interpretation skills as they found it a difficult skill to master and retain [11-15]. Negative affect state toward learning has a substantial impact on the learning process, academic performance,

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and practice of a particular subject [16], but such attitude toward ECG learning has still received relatively little attention in medical education research. The medical tutors appear to have to expand investigation on multitudes of instruction and assessment method in order to improve ECG cognitive knowledge and interpretation skill [11-14]. Apparently, Kopeć *et al.* highlighted that there were qualitative and quantitative deficiencies in teaching ECG interpretation [15], and it was found that there was no single effective ECG instructional method [17].

In most disciplines, the students' attitude toward learning a particular subject is considered extremely important [18]. Educators are interested to know the perception and attitude of their students toward learning. Many researches support that students' attitudes toward learning of subjects are important in course outcome, knowledge, and skills [19]. Positive attitude toward learning is vital as it encourages students to get interested in the core knowledge and skills of the study [20]. On the contrary, students with a negative attitude are afraid of the progress of learning, and consequently, their understanding of the subject and their class performance are adversely affected [21].

In other studies, it was noted that when the students felt depressed and were at risk for failure, they were often highly emotional and could not move forward which then restrained the process of learning [19,21]. Therefore, lecturers frequently face huge challenges when learners lack interest and have negative attitudes toward learning [19]. A qualitative data inquiry conducted among students with negative attitude yielded five categories of responses, which are (1) difficulty in comprehension [18], (2) not useful in future career [22], (3) dislike for subject [22], (4) not part of the major, and (5) dislike for lecturer. These learners showed signs of negative attitudes such as feeling tired when following the course, unable to gain the benefits of the course, incapable to focus in class, tend to interfere during class progress, and absenteeism.

In addition, it was reported that negative expectations influenced the negative emotional conditions and attitudes toward learning [23]. Learners with a negative attitude can be recognized by their class anxiety due to their poor interest in the subject and were not enjoyable in courses [19]. As a result of pervious study, the negative attitude became an obstacle in the learning process [16]. Furthermore, the findings from "bench-mark" studies conducted among graduate and undergraduate students indicated that the subscale marks reveal a relatively negative attitude toward learning in the learners' field of study [20]. Consequently, negative attitude toward course has great influence on student learning processes, thinking, and improvement in their professional life [24].

Studies have reported a lack of proficiency in ECG interpretation as well as a perceived inadequacy of ECG training among medical students and young doctors [4,13]. Without comprehending the students' negative attitude toward ECG learning, the educators would not be able to address their incompetency in ECG interpretation in spite of putting significant emphasis on ECG teaching method. By understanding students' perceived difficulties in ECG learning, medical teachers are capable to construct a proper ECG undergraduate curriculum based on deficient points in ECG teaching and learning. To date, there is no study done on factors responsible for negative attitude of medical students' toward ECG learning. The purpose of this study was to assess the undergraduate students' difficulties in ECG learning and hence help educators design appropriate ECG learning curriculum to instill competent skill in ECG interpretation based on this outcome.

Materials and methods

A total number of 324 of 348 undergraduate medical students from different academic years participated in this study, and the response rate was 94%. This qualitative study was conducted at the Faculty of Medicine and Health Sciences in East Malaysia, University Malaysia Sabah. Both preclinical and clinical year medical students at the beginning of the academic year 2017–2018 were selected because ECG theory and its application is taught as one of the major learning outcomes spirally across different academic years. All students were taught by outcome-based education curriculum as it is a single-center study. Ethical approval was obtained from the Institutional Ethical Board (JKEtika 1/17[5]). Consent form was signed and taken before the study after detailed explanation of the study to each participant student.

Nonprobability convenience sampling was applied in this qualitative study. The data collection was conducted through a Google Form online survey which consisted of collecting participants' demographic characteristic data such as age, gender, ethnicity, and academic profile such as the current academic year and cumulative grade point average (cGPA).

The qualitative survey was constructed to gather the required information about the affective states of ECG learning. Those participants who showed negative affective states in ECG learning answered the further open-ended questionnaire "what are the students' perceived difficulties in ECG learning?" in order to explore the motive undermined it.

The thematic analysis was used to identify patterns in the data and uses themes to interpret the data [25]. Qualitative data collection was carried out by an independent researcher. Open coding was used to analyze student responses to open-ended survey prompts. One author reviewed all comments and placed them in categories, and a second author reviewed and verified the categories. The data collected in this study were analyzed using the six-step framework developed by Braun *et al*. [25].

- Step 1 – The first step in this thematic analysis involved the reading and re-reading of the transcripts. This enabled the researcher to get familiar with the data
- Step 2 – This step is concerned with developing initial codes. In this phase, the data collected were organized in a systematic and meaningful way. Based on the fact that this is a theoretical thematic analysis, each segment of the data that were relevant to the research question of this study was coded. An open-coding method was used to code the data. The initial codes were modified and developed during the course of the coding process

- Step 3 – This step involved searching for themes with similar patterns that capture an interesting or significant fact about the data collected. The codes were examined and collated into an initial theme. At the end of this step, all the codes were organized into broad themes that captured something significant about the research question
- Step 4 – This step involved the review of themes. The preliminary themes identified in the previous step were reviewed, modified, and developed. This was done by collating and reading all the data that are relevant to the theme. This was done to determine if each theme truly supports the data or works in context with the entire set of data. In this study, the data set is one extract
- Step 5 – This step involved the final refinement of the themes to identify the essence of the themes
- Step 6 – This is the final step in this thematic analysis. It involves writing a report on the results obtained using this method of analysis. The results of this thematic analysis were reported and discussed in this study.

This approach was selected because it provides a usable and clear framework for conducting thematic analysis. During the transcription, all the participants' responses were put as theme and subtheme categories of similar responses together. This enabled the easy interpretation of the thoughts associated with each theme. The participants' identity was made anonymous to ensure that the confidentiality rule of research ethics was adhered to. The detected emergent themes could be used as a foundation upon which medical educators might put an emphasis on addressing such challenges to improve ECG teaching and learning. The Google Form survey data were downloaded to Microsoft Excel (2016 version) and were further processed, cleaned, and analyzed using Statistical Package for the Social Sciences, version 24.0 (SPSS Inc., Chicago, II, USA). Academic year, ethnic groups, and each theme were presented using frequencies (%). Analysis of age and cGPA resulted in a normal distribution and displayed as mean (standard deviation [SD]).

Results

More than half (200/324) of the students had negative attitude toward ECG learning. Majority (55%) were female with mean (SD) age of 21 (1.25) years from different academic study year of preclinical (year 2) and clinical (year 3–5) students (year 2: $n = 42$, 21%; year 3: $n = 52$, 26%; year 4: $n = 46$, 23%; and year 5: $n = 60$, 30%). The mean (SD) cGPA score was 3.48 (0.23). Extensive thematic analysis of open-ended questionnaire portrayed five major themes which are in align with Anderson and Krathwohl's cognitive process levels: (1) lack of remembering (18.2%), (2) lack of understanding (28.4%), (3) difficulty in applying (3.6%), (4) difficulty in analysis (15.1%), and (5) difficulty in interpretation (17.8%). These cognitive difficulties were also adversely underpinned by different array of knowledge dimensions such as factual, conceptual, and procedural knowledge. The following thematic analysis of students' responses reveals how ECG learning difficulties are perceived at both knowledge and cognitive process levels.

Lack of remembering of factual knowledge

Around 18% of students found difficulties in factual remembering of standard ECG parameters such as calculation formula of heart rate, normal and abnormal duration of different waves, segments, and intervals, so on and so forth. Year-5 students had more difficulty in remembering than other year students. Furthermore, students with low cGPA had more difficulty in remembering than higher cGPA students. However, there was no statistically significant association between academic year, performance, and perceived ECG learning difficulties (Chi-square test = 23.828, df = 15, $P > 0.05$; Chi-square test = 4.925, df = 5, $P > 0.05$). The statements below were the summary of students' opinion:

"The normal duration of the waves is difficult to memorize. I forgot what I had learnt after a while as I learnt it by heart" - Memorization technique.

"It is hard to remember. ECG learning is easily forgetful".

"ECG different pattern is unable to memorize. ECG learning outcome is too many to remember" etc...

Lack of understanding of conceptual knowledge

Majority (28.3%) of students felt that lack of understanding conceptual knowledge is the major cognitive factor that contributes to ECG incompetency. Further analysis of the students' response indicated that they found difficulties in understanding three learning outcomes: (1) basic anatomy and physiology of heart, (2) 12-lead system, and (3) vector. This lack of understanding is mainly due to the complexity of the mechanism underlying ECG that makes them perplexed. In contrast to remembering, high cGPA students found more difficulty in understanding conceptual knowledge. The statements below were the summary of students' excerpts about difficulty in comprehending basic knowledge of cardiology:

"My basic science during preclinical year's knowledge is not good enough. It's either I can't comprehend the things I've learnt or my basic knowledge of cardiology is not good enough."

"I can't understand the basic concept behind the abnormalities of ECG patterns."

"I haven't fully mastered the basics but I will try my best to do so."

"I am very keen to learn but ECG is confusing as the waves look quite the same and we were not thoroughly learnt step by step since the pre-clinical year to read ECG."

"I am still quite confused with basics of ECG; sometimes the explanation is too fast. I am in need of moderate speed explanation from basic so that I can master more clinical problems regarding ECG."

"I have a poor understanding in cardiology."

Second key difficulty that the students perceived was their ability to understand 12-lead system. Clinical year students commented, "It's hard for me to imagine the lead system." An interesting example was noted by a clinical year student:

"Too many leads to see. It's like too many pots of soups boiling at the same time. I don't know when to see what and which. I need a personal tutor!!!"

In contrast, one preclinical year student perceived that:

"I am not really familiar with the normal waves (especially readings from different leads, aVr, aVl.....); hence hard to see what's abnormal in them."

"Without knowing the normal 12-lead ECG, definitely there would be problems interpreting a pathological ECG."

Regarding the difficulty in vector concept, another student pointed out as such:

"It's really hard but if I can understand vector concept, I would be really happy."

"It's like the joy of solving mathematics question. I cannot really understand if I learn by my own."

"I cannot understand the particular ways every leads and how ECG works."

Procedural knowledge: Difficulty in applying, analysis, and evaluating

A minority (3.6%) of students felt that they have difficulty in applying the concept what they had learnt in clinical ECG. Here, the researcher provides the extracted answers in more detail to support this finding:

"Although I had knowledge about ECG interpretation what I had read several times, it's difficult to apply and most often my thoughts got stuck when seeing ECG especially 12-lead."

Difficulty in analysis and interpretation were somehow animus. The students' inability to analyze and interpret 12-lead ECG was also noted in various comments (33%). A participant mentioned that:

"It is difficult to analyze rhythm, identify waves, recognize abnormalities in especially 12-lead ECG, correlate with patient condition and come up with a correct diagnosis."

"I took a long time to read 12-lead ECG strip."

"Everything looks same to me."

"I struggle to look at which lead to see at the 12-lead ECG paper all the time and decide which diagnosis."

The clinical year students felt that learning ECG is difficult because there were lots of features to look for in a single graphic paper. It seems may be due, in part, to the negative affective state of learning as the vastness of 12 different leads in a single ECG paper daunted the students to interpret it in three-dimensional view of the heart.

Unclassified negative perceptions

Five percent of the students perceived that there was inadequate exposure and not enough ECG classroom practice to sharpen their skills; as a result, they could not perform well during ECG examination questions. Twelve percent of the participants revealed lack of proper guidance which prevented perceived progressive learning. In addition, lack of contact time with lecturer resulted in fewer hands-on experience and proper guidance on interpretation of ECG. Here is an example of students' comment:

"ECG is a vast topic to learn and requires time and full attention."

"ECG teaching time isn't adequate in the curriculum."

"I want more ECG classes in every year to refresh my memory."

Discussion

Bloom's taxonomy has been utilized in many fields of studies [26]. It has also been used in the assessment of medical education, but research on the application of taxonomy of the cognitive domain into ECG learning outcome has not been made yet. The research findings of students' ECG learning difficulties were surprisingly found to be in align with Anderson and Krathwohl's Revised Bloom's taxonomy of cognitive domain (2001) [27,28], such as (1) lack of remembering of standard ECG parameters; (2) lack of understanding of basic anatomy, physiology, and pathology of heart; (3) difficulty in applying ECG knowledge into clinical diagnosis; (4) difficulty in analyzing how different ECG leads interrelate; and (5) difficulty in process of interpreting 12-lead ECG, which appeared to contribute negative perception and attitude in ECG learning. Of great concern, it is alarming for educators to fill the learning gap between those difficulties and ECG instruction curriculum.

Our findings revealed that remembering is the second most perceived difficulties in ECG learning. Similarly, Hurst highlighted that "without contact with ECGs for several weeks or months, he or she may be unable to interpret them." This failure is predictable because the individual did not learn to interpret ECGs in the first place. The brains of most people are not designed to memorize countless numbers of ECG patterns [29]. People learn and emphasize the difference in memorizing information, thinking, and learning. As a solution, Dong *et al.* (2015) suggested using a concept map to memorize ECG interpretation method [30]. To note, high cGPA students scored high in the past years utilizing their memory rather than utilizing their understanding power. The reason behind might be a loss of memory retention as the time lapses which primarily results from lack of understanding of conceptual knowledge of 12-lead ECG system in relation to the functioning of different aspects of the heart that was not properly understood. The medical curriculum needs to be reiterated that ECG learning is a topic of understanding, but not by memorizing except for the standard height and width of ECG morphology.

The perceived difficulties in ECG learning were further integrated into the following three levels of knowledge – factual, conceptual, and procedural knowledge. Cracolice *et al.* studied concept learning versus problem learning in chemistry education [31]. Likewise, in learning ECG, the understanding of basic concepts (conceptual learning) and solving abnormal findings (procedural learning) are very important for accurate ECG interpretation. Conceptual ECG knowledge infers to the

understanding of vector concept and basic theoretical knowledge of cardiology, while procedural knowledge refers to the understanding of how to apply the concepts learned in analyzing and interpreting ECG. While pre-clinical year students found difficulty in calculating basic ECG parameters, clinical year students found difficulty to differentiate normal versus abnormal ECG.

Furthermore, it was found that vector analysis and the waveform in relation to the flow of electromotive force along the depolarization and repolarization of different parts of the heart [32] were not comprehensively understood by the students. Notwithstanding, Hurst encouraged to use the vector concept to interpret each ECG [29]; it is not widely used to instruct by medical educators nowadays due to its complexity. The clinical year students felt to have higher level of difficulties in consolidating multiple leads to come up with the correct diagnosis. While interpreting the clinical ECG, they failed to visualize the normal patterns and could not detect the abnormalities in vast 12-lead system. This view alarmingly resonates with a quantitative study done by Ohn *et al.*, which revealed that medical students were less competent in interpreting 12-lead ECG compared to single lead rhythm strip ECG correctly [33]. It was also commonly perceived that the teaching and revision time for ECG class was insufficient which resulted in a lack of motivation and confidence. In view of limited student–tutor contact time, online and blended learning method, for an instance, using gamified e-learning platform (GaMED ECG@™) [34] protects face-to-face contact time while engaging and motivating students in learning ECG. Gamified learning experience also allows medical students to attain the problem-solving skills of ECG interpretation [35]. Ohn et al. (2018) proposed the gamified online active learning theory in which the incorporation of game characteristics takes effect on positive attitude and behavior of learners through engagement [36].

Our study has several limitations. Generalization of this study result needs to be cautious as this qualitative study used a convenience sampling method. In addition, different curriculum and instruction method might influence students' perceived difficulties. It is suggested to have further studies that could address more comprehensive in-depth interview of students from different universities compared with respective curriculum to find a solution to undermine incompetency in ECG interpretation skill. Future studies with improvement of ECG learning from the negative attitude should also be encouraged.

Conclusion

Negative attitude toward ECG learning poses a serious threat to acquire competency in ECG interpretation skill. The concept of student's memorizing ECG is not a correct approach; instead, understanding the concept and vector analysis is an elementary key for mastering ECG interpretation skill. The critical challenge in learning ECG was a lack of understanding the basic concept of cardiology, ECG wave, morphology pattern, and vector analysis which leads to ECG incompetency. Therefore, by focusing on such students' deficient points, the educators can improve the students' knowledge, confidence, and skill in ECG interpretation. In conclusion, the finding of this study sheds light into a better understanding of medical students' deficient points of ECG learning in parallel with taxonomy of cognitive domain and enables the medical teachers to come up with effective and innovative strategies for innovative ECG learning in an undergraduate medical curriculum.

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Conflicts of interests

There are no conflicts of interests.

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