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EDUCATION

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Reading the Electrocardiograph: Paramedics' Descriptions of their Learning

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ABSTRACT

Objective
If we know how students learn to read the electrocardiograph (ECG) then instructors can modify their teaching practices in order to optimize student learning. The aim of the study was to record cognitive functions that paramedics describe when they are learning to read the ECG.

Research Question
Answers were sought to the research question: *What activities, strategies and cognitive elements do paramedics describe when they are learning to read and interpret ECGs*?

Methods
Twelve participants were interviewed. Data were coded into six themes with 51 sub-categories. Content analysis was concerned with description, induction, generation, and construction in terms of commonality in how ECG learning occurred.

Results
Students learning were categorized into six themes:

- *BASIC LEARNING ACTIVITIES* - elementary skills derived from reading, writing, and math.
- *TRANSFORMATION OF INFORMATION PROCESSES* - comprehension, memorizing, differentiating, and examining against a given criteria and three-dimensional mental imagery and visualizations.
- *LEARNING INTERACTIONS* - activities of learning sourced from other than direct classroom instruction.
- *CONTEXT OF LEARNING* - informal learning with selected peers.
- *SELF-REGULATORY LEARNING EVENTS* - taking responsibility for learning.
- *AFFECTIVE LEARNING* - students' thinking and feeling about their learning.

Conclusion

Paramedics make life-and-death decisions based on actions from their learning. It is imperative that students are given the support to learn, in a manner that is conducive to the way that the say they learn and instructors need to understand how students go about their learning and incorporate these processes into their teaching methods. Each student identified their use of three-dimensional mental visualizations to be a contributing cognitive function, therefore, instructors need to consider incorporating this approach into instructional design as a way to optimize and strengthen students' learning about ECG interpretations.

Introduction

When a person experiences a cardiac event, initiating treatment through cardioversion and administration of life-saving drugs relies on accurate electrocardiograph (ECG) interpretation. The purpose of the study was to record cognitive elements that paramedics use when learning to read and interpret meaning from the electrocardiograph. Knowing what learning strategies and approaches paramedics use has impact on subsequent teaching methods set to optimize students' learning styles.

The investigation was designed to generate data and conclusions that were relevant to the project key question: '*What activities, strategies and cognitive elements do paramedics describe when they are learning to read ECGs*?' 'Elements' referred to those cognitive events that paramedics were progressively thinking when they learned to read the ECG.

This study considered the works associated with learner-teacher interaction, andragogy, self-regulation, skill acquisition, domains of learning as well as educational theorists including: Bloom,[1] and Krathwohl's revision of Bloom's original work,[2] Knowles' Principals of Adult Learning,[3] Lawson's framework of cognition,[4] Thomas's schemata of mental imagery,[5] as well as that of constructivist theorists: Vygotsky, Minsky and Piaget.

Within the classroom we know that students control their learning to a significant extent and we know that they undertake complex forms of mental activity to learn.[6]

As teachers, we need to know what learners are doing and what mental activity is being undertaken during their learning. If we can learn more about how learners are carrying out their learning we can give teachers opportunities to develop more sensitive teaching actions, which are predicted to result in deeper learning by students. It is recognized that the outcomes of classroom education depend heavily on the actions of teachers; previous research has recorded that, from the outcomes of student achievement at school, 59% of the variance is related to teachers' actions.[7]

It is common practice in many Emergency Medical Services institutions of education to employ instructors who have demonstrated excellence as clinical practitioners and exemplary skills in reading and interpreting the ECG, yet those instructors have no background of formal theory of education. While there is no regulatory requirement in Australia for instructors to have a background within an education discipline, instructors need to take responsibility to incorporate recognized principles of teaching practice into their classroom instruction. Without this, the quality of instruction delivered may be less than optimal.

Study design

The study was positioned within the qualitative research domain. It aligns to the interpretive approach, as it was retrospective, qualitative and descriptive in its properties. Interview was used to enable participants to describe their interpretations and to express their understanding

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of how they went about their learning. This was significant in order to determine the outcomes that encapsulated a sociological and ethnographical picture of what was happening during their learning.

Each interview was semi-structured and posed open-ended questions. The interview was audio taped. Guided interview questions allowed each student paramedic to describe in his or her own terms the learning processes used when learning to read the ECG. The interviews were transcribed. Notes were taken at the time of interview to describe body language or facial expressions in relation to the response that the student was offering. This was important as textual words have the potential to be interpreted in various ways to what the student was actually expressing.

Population and setting

Twelve students from at total of eighteen from one classroom group were interviewed. Six students did not meet the criteria (ie, they had previous ECG tuition) so were excluded from the study. Each student interviewed was attached to an ambulance station in either the metropolitan area of Adelaide or to a country station at a regional town in South Australia. Each student had completed the study program "Electrophysiology and ECG Interpretation" and interviewed within a two-week period following this tuition. "Electrophysiology and ECG Interpretation" comprises part of the second-year topics undertaken over a three-year Diploma of Applied Science (Paramedic) program. This study was offered on an annual basis. The cohort comprised of both males (n=5) and females (n=7). Ages ranged from 20-35 years.

Ethics approval

Approval was authorized by the Social and Behavioural Research Ethics Committee, Flinders University, Australia, and the Chief Executive Officer of SA Ambulance Service and the Ambulance Service Education Board endorsed the study.

Analytical methods

Interview material was examined for text or language that described a learning process. Each descriptor was then sorted and categorised into specific themes of commonality. For example, Code B2 grouped statements that related to skill development. In this category, verbalizations students said that they: "…*look at the wave formations* (S1); "…*look for differences*" (S2); "…*identify specific components*" (S4); "…*search for configurations*" (S4); "…*check the shape (of the ECG) against the criteria*" (S5).

A computer software program was initially used to process the data. As the analysis procedure developed, the software program was deemed inadequate as the researcher sought more precise and refined data analysis than what the software program was able to provide. Consequently, manual analysis was performed to ensure that explicit data were coded for analysis. To ensure consistency, the text analysis underwent two inter-reliability and intra-reliability testings to ensure validity and to provide evidence of validity. The inter-rater reliability check indicated 88% agreement on code allocations.

Results

The transcripts yielded six major categories attributed to learning and the analysis of these categories is identified in Figure 1.

Figure 1: Descriptions of paramedics' ECG learning events and examples of sub-categories.
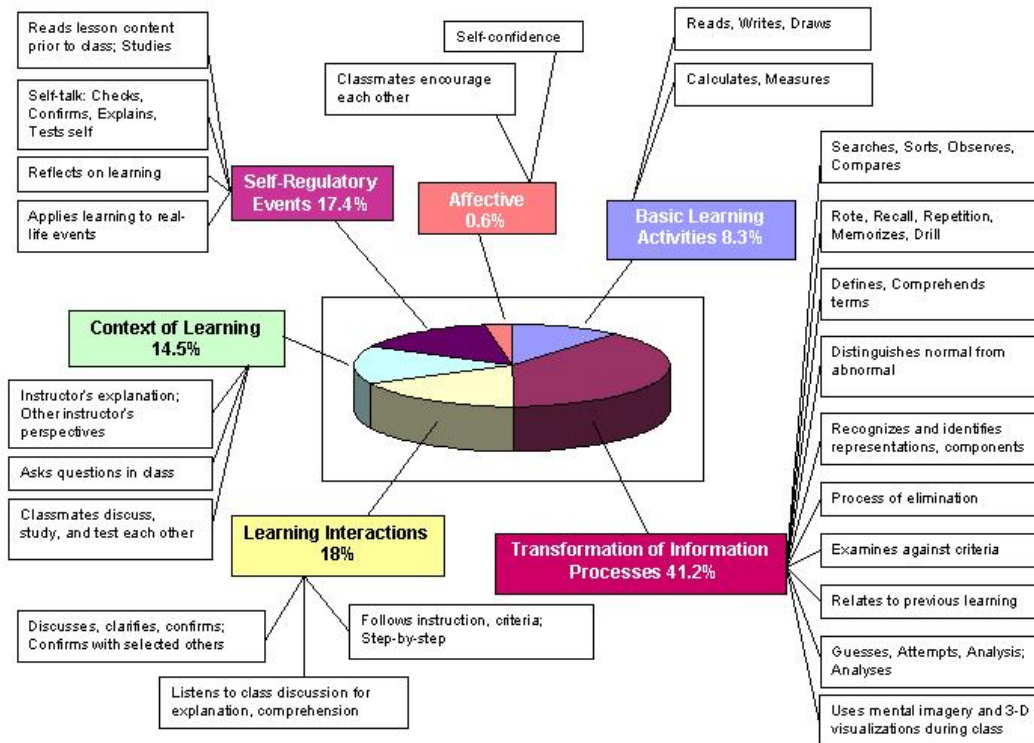
Basic Learning Activities coded 8.3% of themes that related to elementary tasks of reading, writing, counting, and measuring. Students described that they read the course material and reference texts in order to learn. This took place during class as well as during self-study time. Therefore his theme was complementary to self-regulatory events whereby students took responsibility to study their lessons through reading the reference material and calculating exercises in order to master the skill.

Transformation of Information Processes coded 41.2% of skills attributed to comprehension, recognizing and differentiating components of the ECG, attempting to analyse the ECG, and examining the ECG rhythm against the given criteria. This theme generated most of the discussion that students offered at interview. The data analysis readily identified that students are able to describe cognitive events that they use to learn. Use of three-dimensional visualizations and mental imagery were unexpected categories that emerged from the data. When listening to the instruction students said that they used mental imagery and three-dimensional visualizations to follow physiological activity of the cardiac and conductive system. They reported this imagery to be a powerful learning strategy.

Learning Interactions coded 18% of activities that primarily required interaction with others; this included interactions as associated with listening to the instruction, discussing their learning with others, and following the instructional guidelines. Working through the given criteria one step at a time provided an early foundation from which further learning could be added.

Self-Regulatory Events coded 17.4% of activities associated with students taking responsibility for their own learning. The importance of this theme identified motivational efforts that adult learners demonstrate when attending to their learning needs. The data

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analysis readily identified that students chose to make the effort to attend to their own learning requirements.

 Context of Learning was coded in 14.5% of the events; this theme categorized notions associated with knowledge confirmation, asking clarification questions in class and at the student's allocated ambulance station, and with selected peers. Students identified that they used mentors to clarify their learning. This strategy is significant as learning is strengthened when others provide explanations and clarifications in an environment that is supportive toward the student.

Affective Learning was described least (0.6%). While two students referred marginally to this concept, it was not expanded as a significant approach to learning. Students could well do with being reminded or explained about the benefits associated with the affective domain of learning in order to strengthen the way they go about their learning.

Discussion
The analysis revealed that there was a large amount of cognitive activity going on during instructional periods and there was a wide range of activity being undertaken by students.

There was one most significant cognitive approach that emerged from the interview text that differed from those described in the literature or from what was anticipated. Students' described their use of mental imagery and three-dimensional visualizations as a way of following the instruction and to make meaning of the lesson content. Students said that during instruction they could "see" mental images of the instructional content in their mind as the instructor described the functioning of the cardiac conduction system and other activities of cardiac physiology. This descriptor emerged as a significant point of interest in the study.

Repetition, practice, recall, drill, and quiz were highlighted in all of the interviews. These themes were predicted and anticipated; repetition exercises strengthen ability to memorize formula and criteria for use at a later date. Students verbalized that they needed constant repetition to assist the transfer of information to learning; they stated that self-repetition, constant practice, searching for components against the given criteria was directly related to their learning. It could be argued that repetition equates to rote learning. Students insisted that constant repetition of formula assisted with memorizing details so that those formulae could then be applied to different ECG rhythms. Distinctions were made between simple repetitions for memory maintenance with repetitions for elaborative rehearsal.[8]

It was expected that students would raise the teaching methodology of "classroom discussion" as significant to their learning however it was surprising to note that this was rarely mentioned (0.07%). This suggests that there may be little teaching time set aside for class discussion during which students could discuss themes to support their learning. In contrast to this students said that they chose to find their own mentor to assist and clarify any points of learning.

Each student stated that they followed rigorous adherence to instructional guidelines, (10.32% of the theme, *Learning Interactions*). From one point of view, it could be argued that by "following instruction" learning is constrained and has limitations. While this contention is acknowledged, the counter-argument reminds us that learning about ECG patterns is built from simple foundations before moving to those more complex configurations of the ECG. Therefore, by adhering to the rules, the student is provided with a degree of security.

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The notion of instructor effectiveness and how the student interacted with the instructor was said to impact on student learning. Classroom teaching and learning is a social event and social dynamics occur between people inside and outside the class. Students sought out a mentor or a surrogate instructor with whom they trusted and respected, to clarify points of learning. Instructors need to be aware that mentors play a significant supportive role in student's learning and promote this strategy to support what has been learned within the classroom.

Self-talk was evident; self-questioning is a cognitive event that utilizes information previously given and enabled the student to progress their learning as it expanded the knowledge base from what was known to embrace the creation of new learning. Self-regulated activities associated with planning how to approach a learning task and evaluating progress has involvement with metacognition; this is higher-order thinking, as it involves control over cognitive processes engaged in learning.

While the clinical situation may or may not have had a relationship to a cardiac-related event, students said that they used the patient's ECG recording to attempt interpretation. This has strong learning advantages. It provides the student with factual data that may impact on clinical decisions that need to be made immediately.

Conclusion
The intent of this study was to find out what activities, strategies and cognitive functions paramedic students describe when learning to read ECG interpretations. The data analysis has provided evidence that students are engaging in a wide range of cognitive activity while they are attempting to learn how to interpret ECG patterns. Most of the activity students described related to the transformation of information. This clearly identifies that students are able to process information and then apply this knowledge to new concepts. The data has highlighted that student paramedics who were interviewed in this study learn to read the ECG through utilising mental imagery and 3-dimensional visualisations.

We ask students to learn in our classes but rarely engage them in discussion of how they should undertake this learning. The students demonstrated that they have knowledge of how to learn, though there was considerable variation in the extent of their knowledge. When we pay attention to individual differences in students we need to consider identification in knowledge about learning. This knowledge can be exploited by instructors and referred to explicitly in class sessions. A question such as "How do you remember that pattern?" allows students and instructors to engage in discussion about learning that can be instructive for other students. Students can improve the quality of their ECG knowledge if the quality of their processing activity increases. From this study it would seem that this interaction between the two domains of knowledge is not as close as it might be in the teaching situation.

The researcher acknowledges that this study comprised of twelve cases and that a further study of greater numbers might raise different outcomes. In addition, a similar study of comparative groups, eg, Diploma students from Vocational Education and Training programs and baccalaureate students from University based programs, might also identify different outcomes.

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Author Disclosure
The author has no financial, personal or honorary affiliations with any commercial organization directly involved or discussed in this study.

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