

**Implementing some Memorizing, Thinking and Motivation
Physiological Mechanisms in Computerized Interactive Teaching and Learning
Cardiovascular Physiology on Different Levels of Complexity**

Keywords: cognitive domain, education efficacy, motivation and thinking, teaching and learning, medical physiology curricula.

Introduction:

There is a large preoccupation during last years on methods that can improve education efficacy and efficiency in medical field in general and in physiology in particular. There are numerous studies concerning ways students prefer to receive information (Sensory Modality Preferences – SMP, Fleming’s VARK- Visual, Audio, Read/Write, Kinesthetic), ways students learn (Kolb’s Learning Styles Inventory – LSI), ways students approach the learning process (COLS - Conceptions of Learning Science and ALS - Approaches to Learning Science questionnaires), the degree students are willing to learn by themselves (SDLRD – Self Directed Learning Readiness Scale). There is also a significant amount of papers dealing with e-lecturing and i - (internet) - lecturing, asynchronous classes, active learning (active lecturing, cooperative and collaborative learning), Student Centered Instruction – SCI, Concept Mapping, Peer-Assisted Learning – PAL, Peer Teaching and Near-Peer Teaching. Finally, there is a growing body of literature on assessing teaching results: tests formats, self-evaluation, repeated evaluation, evaluation during lectured courses (“clickers”), formative - during semester evaluation and summative – final evaluation.

Aim:

The aim of this work was to propose a complete functional computerized set of alternatives to current educational process in the cognitive domain in our Physiology Department particularly, but with application in other preclinical disciplines of our University as well. We chose from physiology the cardiovascular chapter because it seems to be the most difficult for our students and anyway physiology is vast and we had to start from somewhere. The proposed alternatives in their turn aimed to improve students’ memorizing and understanding skills as well as thinking and motivation skills of both students and teachers in the process of learning and respectively teaching cardiovascular physiology.

Material and methods:

The work was done in several stages on several plans. According to Bloom’s taxonomy of the educational domain, we focused on the first three levels of the cognitive and affective domains: memorizing/recall, understanding, applying and attention/reception, reaction and valuing respectively.

1. We tried to correlate, in cognitive domain, the second year medical students' oral evaluation results to the efficacy of education they were provided, over our medical physiology curricula between 2004 and 2011. We defined education efficacy as the degree the educational objectives were achieved and we quantified this by the grades/marks students got at the final session oral exams. We used the fact that during the mentioned period the curricula configuration for the two semesters of the second year was identical. We also used the fact that, for a given group of students and curricula, education and evaluation were performed by the same teacher. We compared three existing and unmodified configurations: 1. different groups of students, same curricula, different teachers, 2. same group of students, different curricula, same teacher and 3. same group of students, different curricula and different teachers. We also took an inside brief evaluation of students' skills in cognitive domain at the beginning of the second year and tried to correlate it with final results.

2. We defined levels of complexity in studying cardiovascular physiology as entities that are to be assimilated strictly one after another, passing to a higher level being possible only after previous level has been fully completed, that is every educational objectives within it, identified according to initial or revised Bloom taxonomy in cognitive domain, are achieved. Different groups of medical students were tested in the fall of the year 2009 and 2010 consequently during the first four and five weeks respectively at the beginning of cardiovascular physiology class. One test consisted in 5 questions calling for free answers in a 'low level of complexity' we titled 'blood flow through cardiovascular apparatus', level we assumed that has been fully accomplished by students during gymnasium, high school or other previous disciplines in our faculty. Then we evaluated students' skills in a 'higher level of complexity' titled 'Ions flow through cellular membrane', level which our cardiovascular physiology course begin with and so the evaluated skills normally/probably being accomplished at the time of testing. We defined protocols to evaluate current and evolution of students' understanding and motivation skills.

3. We defined Key Triads (KT) as a two to three words connected by logical operators 'and'/'or' and we used as many KT as necessary to define a physiological concept. Then we developed personal software that is able to search and recognize these KT within an MCQ set. We developed software to present the search results as a KT map. We searched the 1962 MCQ set, used previously for Biology exam in our University admittance session, for physiology concepts like 'arterial pressure', 'blood flow', etc.

4. We refined the old computer aided concept we developed several years ago for teaching and learning medical physiology, by adding new tools to enhance motivation and thinking of both medical students and teachers. Since all the future exams of our University will rely mainly on a written, or even better, computerized multiple choice format, we focused on tools that motivate teachers in writing good multiple-choice questions (MCQ), not only for final exam but for teaching students as well, and tools to motivate students to perform MCQ tests during semester.

5. We defined our computer aided concept for Student Centered Instruction. This consists basically in a combination of the students performing self testing on an MCQ set and of the teacher performing surveillance of students' willingness to test themselves and of students' results to the tests. Teacher will be able than to educate each student on those issues which student cannot solve by himself.

6. We used the 2012 admittance protocol in our University in order to prove that if we construct groups of students by systematically sampling them from the whole alphabetically sorted group, then education on a same physiology curriculum of each different group by a different teacher can be a better alternative to the actual situation: one curriculum – one teacher. We will further name these groups 'Alpha Groups' (AGs). We used 4 large AGs of about 160 students and 4 small AGs of 40 students who were tested, during our University 2012 admission session, on a human biology (pre-physiology) curricula by 100 Multiple Choice Questions (MCQs) of which 75 questions were evaluating mainly memorizing skills and 25 MCQs were mainly thinking questions. We calculated the average and variance of marks for each AG on each type of MCQ and we analyzed for each AG the values of P and D indexes in each MCQ. We statistically compared the results between AGs. We can link MCQ quality to the teachers by a protocol in which several teachers are writing each different MCQs that will build up the MCQ set on which students will be assessed in final exams.
7. We defined our own computer based environment in Visual FoxPro 5.0 and we wrote modules using object oriented programming. For specific topics we wrote modules using procedural programming in FoxPro 2.0 and/or Turbo Pascal 6.0.

Results:

1. We couldn't make any correlations between the second year medical students' oral evaluation results and the efficacy of education they were provided in cognitive domain over our medical physiology curricula between 2004 and 2011, because of logical contradictions of the configurations we compared. We couldn't obtain, as an outside observer, concise information of what levels in cognitive domain students were evaluated on by different teachers. As an inside observer we merely can say that education of the second year medical students over our physiology curricula cannot be efficient for a large amount of students who do not possess those compulsory cognitive skills that are required to study physiology.
2. We found that more than half of our medical students have many lacks of knowledge, understanding and thinking/applying skills and that they also react poorly to these insufficiencies. More, we found that students don't value enough the information the lectured course provided them. We found that more than half of our students don't have intrinsic motivation but nevertheless weekly evaluation of students can improve their motivation to learn. We found that it is opportune to construct such levels of complexity that will guide students in achievement of educational objectives, in cognitive and affective domain as well, within each level of complexity. We found that there is no benefic transfer of cognitive skills from a higher level to a lower one. Also, students' skills progress in cognitive domain in a higher level is tributary, as expected, to lack of same skills that had to be gained in some lower levels.
3. We found no MCQ in the mentioned set that can teach and/or verify students if they understood the concepts we searched for. We showed anyway that concepts can be mapped by MCQs and that our computerized tool is also helpful for check validity of a given MCQ set.

4. We developed a concept of a Multifunctional or Enhanced MCQ which offer teachers, when using our software, the possibility to write questions with one statement and up to 10 answers which in their turn can be individually enabled or disabled by them. We conceived a precise protocol for calculation of Current P index and Current D index of each MCQ which is useful for a permanent, during semester, refining of poor quality questions or to adjust current overall difficulty of the MCQ set according to student performances and/or teacher expectancies.

5. We developed software for graphical representation of tests' marks and evolution of average mark for each student. We developed software for graphical representation of each student's marks by chapters even when tests are performed from more than one chapter at once. We developed software in order to memorize for each student which question how many times he answered wrong and to offer him the possibility of performing test on the most difficult MCQs, according to him.

6. We found no significant differences, even between small AGs of 40 students, for none of the parameters. Therefore, if AGs would be evenly educated on a same physiology curriculum by different teachers, they should have the same results on a same neutral final evaluation. If AGs will have significantly different results on a proper MCQ test, that will probably be due to the unequal education they received and this should motivate each teacher to educate well his group of students. Furthermore, we showed that analysis of MCQs can motivate teachers to write good quality MCQs. A hypothetical but potential hierarchy among teachers, according to D index of the MCQs they each wrote, should motivate teachers in writing good quality MCQs.

7. We developed a friendly software interface to the modules we conceived in which teachers can write text or MCQs linked to that text and to the modules we conceived in which students can perform tests or individual study. We developed a computer based environment in which our concepts and protocols as well as the major trends in medical education such SMP, Fleming's VARK, active lecturing, Concept Mapping, repeated evaluation, clickers and others can be implemented.

Conclusions:

1. Education efficacy in cognitive domain cannot be quantified by oral exams because they have no traceability of what cognitive levels students are evaluated on.
2. More than a half of our medical students are lacking, at the beginning of second year, the cognitive understanding skills that are necessary to learn cardiovascular physiology.
3. The lectured physiology course alone has little chance to improve to these students their memorizing and understanding skills during semester.
4. For most of the students there is little benefic transfer of cognitive skills from a lectured higher / more difficult level to a lower unachieved yet one.
5. Students' skills progress in cognitive domain in a higher level is tributary to lack of same skills that had to be gained in some lower levels.
6. More than a half of our medical students have no intrinsic motivation to learn cardiovascular physiology.
7. It is very unlikely that only the lectured course, without student weekly formative evaluation, can significantly improve those students' motivation to learn physiology.

8. We propose education protocols based on levels of complexity as we defined them and frequent evaluation of our students in cognitive domain using MCQ tests.
9. It is useful to start with a lowest possible level in order to fulfill all skills that are required at the beginning of cardiovascular physiology course.
10. It is also opportune to continue with small steps between levels of complexity to avoid new skill gaps and to be able to guide students in achievement of all educational objectives within each level of complexity.
11. We developed and we propose our computer aided protocol for concept mapping using a formative MCQ set.
12. We propose clusters of MCQ for each level of complexity.
13. Our computer aided protocol for concept mapping can be also useful for assessing an MCQ set validity.
14. We developed and we propose our concept of Extended MCQ in order to closely link the education with evaluation and hence to increase students' thinking and motivation to learn during semester.
15. We developed and we propose our concept of current MCQ analysis while frequently evaluating students during semester.
16. We developed and we propose computerized tools to support our format of student centered education embedded within the classical curriculum centered education.
17. We introduced the idea of „alpha groups” and we propose a computer aided competition between teachers that educate these „alpha groups” on a same physiology curriculum.
18. We propose a protocol for an MCQ set construction and MCQ analysis that can motivate teachers to write good quality formative and summative MCQs.
19. We developed and we propose a computer based environment in which our previously concepts and protocols can be easily implemented.
20. We developed and we propose a computer based environment in which major trends in medical education can be implemented.