A Course Evaluation Tool Based on SPICES Model, and its Application to Evaluation of Medical Pharmacology Course

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Abstract

Background and purpose: *The SPICES model has been proposed to be used both as a framework for quality improvement in medical education and as a guide for evaluation of curricula. The six strategies of SPICES are representatives of innovative approaches to medical education, and each one has been considered as a continuum. The present study models a theory-based questionnaire, based on SPICES, to be used as a course evaluation tool, through developing a conceptual model for each continuum of the six.*

Methods: *At the first step, operational definition and questionnaire development was performed as an extensive literature review and consensus building in a focus groups of experts .The content and face validity of questionnaire was confirmed. In the second phase-as a pilot -, the questionnaire was used for evaluation of Medical Pharmacology course at Isfahan University of Medical Sciences.*

Results: *The results showed that Medical Pharmacology course located in the traditional end of SPICES continua according to the most aspects of the course.*

Conclusion: *The pilot study showed that the questionnaire scale should be changed. Also it may be more feasible and valid if an item bank is prepared based on the proposed matrix and appropriate items are selected according to the general situation of the curriculum.*

Keywords: *SPICES MODEL, EVALUATION*

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Introduction

SPICES model is known as a useful framework for quality improvement in curricula. Harden explained this model in 1984 as a series of strategies for moving toward innovative curriculum in medical education (1). The model depicts six continua to figure out the position of curriculum. The acronym is taken from six strategies which are employed in innovative curricula at the extremes: Student-centered, Problem-based, Integrated, Community-based, Elective, and Systematic designed. In contrast, traditional curricula at their extremes are: teacher-centered, knowledge acquisition-based, discipline-based, hospital-based, standard, and apprenticeship- based. Since then, many authors cited the original article in their references and claimed that SPICES can be used as a framework for both curriculum evaluation and curricular reforms. Later on, Harden explained two continua (out of six), namely, problem-based and integration, separately(2,3). He depicted the stages from being knowledge acquisition-based towards problem-based as 11 steps. Also, he described steps from discipline based curriculum toward integration as "integration ladder". In spite of general agreement on the

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usability of SPICES in curricular evaluation and reform, other continua have been poorly explained.

Tekian used SPICES as a visual scale to explain the position of medical curriculum in several schools (4). Obviously, the resulting feedback from such evaluation could not describe any further decisions to be made by curriculum administrative. Recently, Van den Berg proposed a method for using SPICES in curricular studies(5). His method is based on quantification of different forms of teaching in the curriculum and rating each form regarding SPICES strategies. According to him, moving toward more innovative curricula is attained by changing the ratio of different teaching situations in the curriculum.The present work aimed to provide a pragmatic description for all continua of SPICES and develop a questionnaire to be used for curricular studies; as application of SPICES model requires clear and operational definition for each continuum, as well as understanding the present position of the curriculum/course.

Method

To develop a theory-based tool, the following steps were followed:

Preparing a matrix for course analysis (Fig 1);

To attenuate the complexity of concepts, a matrix was developed. Columns depict the six continua of SPICES which will be further divided into stages for each continuum. Rows are arranged to make course analysis simpler. They represent different aspects of each course which should be explored in evaluation. Extensive literature review was performed on different course evaluation tools to have an extended list of evaluated aspects .Then, the list was summarized into five: 1)Teaching /Learning methods, 2)Learning resources, 3)Student assessment, 4)Course management and organization, and 5)Physical environment. The following operational definitions were made for five aspects:

* Teaching/learning methods: methods which are employed to result in planned learning. It specially focuses on the teacher/tutor- learner interactions.
* Learning resources: all written (text books, handouts, ..) or multimedia (CD ROMs, WebPages ,…) resources which should be reviewed by students to help them attain learning objectives of the course and pass exams successfully.
* Student assessment: measures taken for planning and implementation of student assessments and giving feedback to them, during and at the end of course.
* Course management and organization: the processes run by course administrative in the planning phase as well as implementation, supervision and evaluation of the course.
* Physical environment: physical facilities wherein learning situations take place (including rooms, labs, ..).

2. Providing operational definition about different levels of SPICES continua regarding five aspects of the course.

Extensive literature review on SPICES was the basis for operational definition. Harden's explanation about "Problem-based strategy" and "Integration ladder" was carefully reviewed and summarized into five stages in each continuum. Also according to the literature, basic concepts in other continua were explored and logical stages for each continuum was formulated as follows:

Student-Centeredness versus teacher-centeredness continuum:

Stage I: Students are to follow the prescribed program. There is no assurance or emphasis about considering students' needs and preferences.

Stage II: Course director considers students needs and preferences for course programming, as he/she understands by him/herself, informs students about the program in advance, and students still must follow it.

Stage III: Course director considers students needs and preferences for course programming, as he/she understands by him/herself, informs students about the program in advance. But, students take responsibility in the implementation of the program and may actively participate in the teaching/learning process.

Stage IV: Students actively participate in the programming phase as well as implementation

of the course.
Stage V: Students actively participate in all steps of course management and implementation (planning phase, programming, implementation, and evaluation).
Problem-Based versus knowledge acquisition continuum:
Stage I: General rules and facts are taught, without examples of its application, corresponding to the first stage of the continuum as Harden proposed (3).
Stage II: Applied rules are taught, but there is no planned exercise for application or examples, similar to the second stage of the continuum as Harden proposed.
Stage III: Examples (or problems) are mentioned along with applied rules; either after teaching rules, as examples; or before them, as thinking stimulants .This stage covers stages three and four in the Harden's continuum.
Stage IV: Problem solving is the core activity in the course. Inferring general rules is not intended. Therefore, problems are solved without any inferential activity or with inferring rules applied only to the similar problems. This stage covers stages 5,6 and 7 in Harden's proposed continuum.
Stage V: Problem solving is the core activity in the course, and it should result in inferring general rules. Problems could be written one, or real problems to be dealt with during practical work. This stage covers stages 8 and 9 in the Harden's continuum.
Integration versus discipline-based continuum:
Stage I: Complete isolation of the courses (in terms of objectives, content, teachers, and methods). The same stage is mentioned in "the integration ladder"(2).
Stage II: There is some sort of coordination among related courses, either as awareness of course people about the other courses, or harmonization (through consultations between course directors), or even nesting (2).
Stage III: Co-ordination among courses goes deeper, either as temporal co-ordination (when each discipline provides its own teaching, but in an orchestrated time to others), or as joint teaching (when each discipline shares its own subject in a joint course).It could be more profound to correlate subjects in a complementary activity. This stage covers steps 5 and 6 and 7 in "integration ladder".
Stage IV: Boundaries of disciplines began to be disappeared by providing complementary program or multi-disciplinary courses (steps 8 and 9 in "integration ladder"). As boundaries are removed, a move toward problems or tasks as the main focus of learning becomes inevitable.
Stage V: Disciplines are blended together among inter – disciplinary or trans-disciplinary courses. Themes are the main focus for curriculum organization (steps 10 and 11 in "integration ladder").
Community-Based versus hospital-based continuum:
Stage I: Course is not relevant to community problems, even is not related to common problems in the tertiary care level.
Stage II: Course focuses on tertiary care level problems of the community (hospital-centered).
Stage III: Course is community-oriented in terms of objectives, content and resources.
Stage IV: Course is both community-oriented and community-based; therefore the learning environment and outcomes are relevant to the real state of community.
Electiveness versus standard continuum
Stage I: Course program as absolutely mandatory.
Stage II: Students have a choice about instructors, timetable of course and exams.
Stage III: Besides the previous choices, students can elect some resources and exam questions.
Stage IV: Some course topics are elective. As well, course assignments and methods of student assessments could be elected.
Stage V: Students can choose the method of learning as well as all previously mentioned choices.
Systematic design versus apprenticeship- based continuum:
Stage I: Course description (including objectives, content, and methods of course delivery and student assessments) is not available for students.
Stage II: Course description (including objectives,

content, and methods of course delivery and student assessments) is presented to students.
Stage III: Other than stage II characteristics, course contents and student assessments are relevant to course objectives (internal consistency).
Stage IV: Course objectives are based on needs assessment (external validity).This stage includes stage III, too.
Stage V: Course evaluation is performed along with its delivery and appropriate feedbacks are employed in the improvement spiral.
3. Composing a series of items which represent the position of the course in SPICES continua regarding its five aspects. Since the present curriculum in Iranian medical universities is rather traditional, 52 items focusing on the more traditional extremes of the continua were selected for pilot study (items of the questionnaire are presented in table 1). Also a parallel questionnaire was developed for self assessment of the course by course director.
4. To evaluate the content & face validity of the
items, a group of five experts reviewed all items independently and allocated each item to a cell or cells in the matrix.
Experts were briefed about operational definitions of SPICES continua and course aspects in advance. The group process lasted a half day and complete agreement was reached at the end.
5. A pilot study was carried out for evaluation of Medical Pharmacology Course in Isfahan University of Medical Sciences.
A randomly selected sample of 50 students (out of 100) completed the questionnaire, three days after final exam. The questionnaire was consisted of 52 items with 5 point Likert scale. Sign test and Friedman's test were used for statistical analysis and post hoc Tukey's test was applied as appropriate.

Figure 1. The matrix used for conceptualization of the questionnaire items. As well, it may be used for illustration of the course profile according to the results of the study. Shaded cells represent the position of Medical Pharmacology course in Isfahan University of Medical Sciences (according to the pilot implementation of the questionnaire).

Continuum	**Student- Centeredness**					**Problem-base**					**Integration**				
Stage / **Course Aspect**	**I**	**II**	**III**	**IV**	**V**	**I**	**II**	**III**	**IV**	**V**	**I**	**II**	**III**	**IV**	**V**
Learning resources	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Teaching/learning method	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Student assessments	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Course organization & management	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102
Physical environment	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131

Figure 1. Continued

Continuum	Community-base				Electiveness					Systematic				
Stage / Course Aspect	I	II	III	IV	I	II	III	IV	V	I	II	III	IV	V
Learning resources	16	17	18	19	20	21	22	23	24	25	26	25	28	29
Teaching/learning method	45	46	47	48	49	50	51	52	53	54	55	56	57	58
Student assessments	74	75	76	77	78	79	80	81	82	83	84	85	86	87
Course organization & management	103	104	105	106	107	108	109	110	111	112	113	114	115	116
Physical environment	132	133	134	135	136	137	138	139	140	141	142	143	144	145

Results

In more than 90% of items, item allocations to matrix cells made independently by expert focus group were identical. This may represent considerable validity of the questionnaire for evaluating SPICES continua.

The remaining items were modified before pilot study according to the group agreement. Questionnaire items and their allocation to different matrix cells are shown in table 1.

In pilot study, response rate was 100%, all but one questionnaire completed correctly and used for statistical analysis.

Separate statistical tables were prepared for comparison of mean and standard deviation of item scores (in the Likert scale) belonging to separate course aspects for each continuum. Because of unequal distribution of items in cells, two statistical methods were used. In cases that two cells had representative items, the mean of two items compared using Sign test. And if more than two cells were allocated in a given continuum for a given course aspect, mean scores were compared using Friedman's test (and Tukey's test as post hoc if applicable). The statistical significance level for ل was considered less than .05.

To simplify the complex statistical jargon, significant results inferred from 28 statistical tables are summarized in figure 1. If mean scores had not significant difference, the lower stage in the continuum was shaded as the present position of the course.

To check the reliability of the questionnaire, Cronbachs' ل was calculated as 0.83.

Discussion

Although there is general agreement on the usability of SPICES model in curriculum development and evaluation, practical tools for its application were not developed. On the other hand, communication about theories in the real world, and their implementation requires them to be translated into operational statements. The present work followed common process for translating theories to pragmatic means for implementation. The process was similar to the theory-based instrument development by Copeland and Hewson (6). The steps included conceptual description of the theoretical model, operational definition, and extensive literature review on the available instruments. Of course descriptions made by the original theorist were used for clarification of model (1,2,3,7,8,9).

Table 1. Sample Questionnaire completed in the pilot study. Item allocations to the corresponding cells in the tool development matrix (figure 1) are presented in the middle column.

No	Corresponding cells in matrix	Item
1	47, 57,105, 115	Course objectives were relevant to common community problems.
2	2, 50, 89	Most students were able to use course references.
3	2, 89	The course workload was appropriate to the students' time.
4	3, 22, 109	The course reading material was various and students had choices.
5	22, 34, 43, 47, 97	Students were faced to real cases and problems, thereafter they had to find appropriate learning resources to solve the problem and learn general relevant rules.
6	41	Course content was related to the students' background knowledge.
7	41	Course content was related to its future application.
8	60, 84	Students were clearly briefed about course examinations in advance.
9	62	Course exams were scheduled according to the students' preferences.
10	62, 81, 110	Students were involved in decision making about the type of exam questions.
11	85	All course references should have been reviewed to take good exam mark.
12	85	Exam questions were reasonably selected among all course topics.
13	85	Deep learning was not essential to take exams successfully (this item has reverse scoring)
14	37, 42	Students' were given enough opportunity to make relation between this course and others (via case discussions or other practices)
15	31, 55	Course objectives and contents were presented in advance.
16	31	There was enough opportunity for learning new concepts in the semester.
17	33, 91	Students' opinions were respected to modify the content and methods of course delivery.
18	91, 108	Students had a choice about instructors (among several course instructors).
19	35	Only theoretical principles and general rules were taught.
20	8, 95	Course resources were organized around real examples and in each chapter, general rules were presented after example discussions.
21	8	Besides theoretical rules, there were applied examples and real cases in course resources.
22	8, 18, 76	Statistical information about our country was presented in relevant topics in the course resources.
23	33, 37, 42	During course presentations, students and teachers jointly were dealing with examples and cases to infer theoretical rules and principles.
24	32	Students were given opportunity to participate in class discussions.
25	36	Theoretical content was taught along with examples.
26	31, 55	Lesson objectives were introduced at the beginning of each session.
27	56	Appropriate methods and media was used for presentations.
28	42, 47	Common community problems relevant to the course were emphasized in presentations.
29	60, 85	Exam durations were sufficient for answering all questions.
30	60, 89	After exam, students were informed about the correct answers.
31	89	Students' complaints about exam questions were responded or considered rationally.
32	89	Exam results were announced in a reasonable period after exams.
33	89	Exam sheets were easily readable without misspellings.
34	61, 80	There were optional questions in the course exam(s).
35	64, 69	Exam questions only included theoretical items.
36	66, 71	Besides theoretical items, exam questions included case based applied items, too.
37	67, 71	Exam items merely included applied questions and real cases.
38	71	Some part of exam items was allocated for common applied issues in the community.
39	70	Having sufficient information about related basic courses was necessary for successful exam taking.
40	118	Physical environment of exams was suitable for students (in terms of light, heat, noise,..).
41	2, 89	Learning resources were easily accessible for students.
42	91, 116	During semester, students were asked about their opinion on course content and methods.
43	100, 115	Temporal coordination of course contents to other related topics in the semester was observed.
44	27, 114	Time allocation for each topic was reasonable.
45	114	Learning resources were relevant to course topics.
46	85	Exam questions were relevant to the taught issues.
47	85	Exam questions were relevant to the learning resources.
48	76	Exam questions were designed according to common community problems.
49	91, 108	Students' preferences had a place in the programming of course schedule.
50	119, 124	Number of students was appropriate for class participation and discussions.
51	118, 143	The physical environment (lecture hall, discussion rooms,...) was suitable for students.
52	120, 124	Class room was dividable to small group works, if required.

Besides, descriptions made by other authors about the basis and examples for SPICES strategies and course dimensions were considered in the conceptual definitions(11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21,22,23,24,25,26, 27, 28, 29,30,31,32, 33,34, 35, 36, 37, 38, 39, 40, 41,42, 43, 44, 45, 46, 47, 49, 50, 510 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65).

To expose the multiple dimensions of the main concepts in the model (i.e., course and six continua) to instrument development process, a matrix was developed. This step was clearly depicted to be used by other investigators as a guide for instrument development and simply visualize an essential step in translating multidimensional concepts to operational statements.

In contrast to the method used by Tekian(4), the present tool gives descriptive information about the course, and informs course organizers about next steps in quality improvement.

On the other hand, the present tool could be used for both formative and summative course evaluations. It also may help course people to profile sensible curricular changes within given time period. This feature and its usability in application to both micro and macro level distinguishes it from the method presented by Van den Berg (5) which may be used only for summative evaluations and is not applicable to micro (or course) level. However, the quantification method he proposed could be used as a complementary step for summarizing curriculum status according to results of applying the present tool for individual courses.

A self-assessment version was also prepared parallel to the student version. It may be used in teacher training programs as a guiding checklist for assessing the present situation of courses and planning for change. This version was not studied in the pilot phase.

In spite of all mentioned advantages of the proposed instrument, there are shortcomings to be solved in the future. First, statistical jargon partly due to the scoring system; It seems that Likert scoring adds unnecessary numbers to the jigsaw. Instead, it may be more suitable to put all alternative items in the same course aspect for a given strategy in one question and ask responder to choose the most appropriate item. This measure will not only simplify the statistical complexity, but also decreases the number of questions per instrument.

The second problem is the huge number of items per questionnaire. If we decided to include all matrix cells in the pilot study, there should be at least 145 items in it. To resolve the problem, some cells were excluded according to the traditional context of the curriculum and the nature of pharmacology course which is a theoretical one. Namely, items relating the physical environment of the course to integration and community-based continua were excluded. Therefore, it may be reasonable to prepare a master item bank according to SPICES and tailor appropriate questionnaires based on the curriculum context and individual course specifications. Selection of the appropriate questionnaire could be based on a very short primary inventory. Such item bank may be used for comparative curricular studies according to SPICES, too. Simple software may facilitate profiles to be generated automatically. This may provide enough guides for further steps in the curriculum improvement process, both at macro and micro level.

The third limitation is unessential summarizing of PBL and Integration ladders, as they could be considered in more than 5 stages. It seems that item bank will give evaluators enough opportunity to save time and focus on more relevant position in the continua without missing any step.

Although we tried to allocate only one cell in the matrix for each questionnaire item, there were inevitable interactions and overlaps between continua, as presented in multiple cell allocations in table 1. Also there are logical interactions between cells that may require an algorithmic design for questionnaire components. The maximal interactions are seen between student centeredness and electiveness. Also integration and problem-based strategies have considerable interactions.

According to all above, the present work may be considered as an initial step in explanation and expansion of SPICES model, to be used in

curricular studies in a more meaningful way. Collaboration of different traditional and innovative medical schools will enrich the proposed item bank and provide a valuable resource for teacher training and change planning.

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