EVALUATION OF CASES FOR CASE-BASED LEARNING IN MEDICAL EDUCATION USING A MODIFIED VERSION OF THE OTTAWA CHECKLIST

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Abstract

Purpose: Measuring the Validity and Reliability of the modified Ottawa checklist in evaluating cases designed for CBL. **Methods:** Cases were created by faculty members before and after a faculty development program (FDP); their quality was assessed using a modified version of The University of Ottawa CB template for quality assurance of the CBL by two medical education experts and an expert matter consultant. **Results:** 8 cases were created by faculty members. There was a statistically significant increase in the mean scores of the cases constructed after the workshops. The mean increase in the cases' mean score using the modified Ottawa checklist was 8.417. There was moderate agreement between raters. **Conclusion:** the effect size of the FDP was significant, and the modified Ottawa checklist is a valid, reliable, and objective tool for revising cases created for CBL.

Keywords: Medical education, case-based learning, quality assurance, faculty development.

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1. INTRODUCTION

"There is no international consensus as to the definition of case-based learning (CBL)," said Thistlewaite et al.[(1)] in their systematic review in 2012. However, many definitions were proposed, including that in comparison to PBL and those which describe its roots and goals**.** [(2)] **Case-based learning** (CBL) can be defined as a form of inquiry-based learning that promotes student engagement and active learning. [(2)] It is grounded in the analysis of patient scenarios to restore authentic clinical cases and prompt students to identify and develop problem-solving abilities and high intellectual functions. [(3)] CBL focuses primarily on cultivating students' rigorous clinical reasoning. Faculty members act as facilitators through the case discussion; they raise questions and prompts to support students to integrate their learned knowledge to gather information, interpret and evaluate its importance, deduce, and ultimately resolve clinical problems, thus bridging theoretical knowledge to practice. [(1-4)]

Hence, CBL is beyond knowledge transfer from a faculty member to a student. It involves the development of a student's ability to process information analytically, allowing them to think critically beyond the lecture room walls and question themselves:

"What will I do when I face this situation, and what do I need to do next?" [(5)]

With this inquiry, the CBL session will meet its intended outcome and transform into a traditional didactic lecture. [(2)]

The case scenarios present the most challenging aspect of the CBL process. Effective CBL should depend on authentic cases and scenarios, making the learning more relevant and meaningful to students and preparing them for the challenges and opportunities they will face in the real world. CBL's superiority is due to the case design, which plays a cornerstone in the process. [(6)] Highly demanding cases requiring multi-layered and context-specific decision-making allow the students to learn through trial and error in a safe learning environment. [(1)] CBL helps generate learning experiences but cannot be

met otherwise. [2, 7] The following are considered attributes of compelling cases for CBL.

1.1 **Attributes of effective Case Construction**

Attribute 1 - Relevant

Cases should be relevant and consider the level of learners in the medical curriculum, background information, and needs of the students to keep them engaged and have a sustained level of motivation through the CBL session. It should be aligned with the instructional goals and objectives covering a broad spectrum of cognitive levels. Using real-life cases or scenarios in CBL provides students with a challenging context for learning. [4, 5, 8]

When designing a case, it is preferably to be written as a narrative in the present tense [9] to start with a setting of the narrative, e.g., "at the emergency department," "at the clinic," etc.[6]

Attribute 2 – Realistic

Cases that resemble real-patient encounters increase the likelihood that students will transfer their learning from the educational, clinical setting to actual practice as a practitioner. Realism can be achieved while constructing cases by adding:[10]

- **Authentic materials**: pointing to the case as a real person reflecting the students' contextual and cultural background enhances the case's authenticity. Actual clinical cases encountered at the hospital and available in the medical office records can be used as models. Cautious use of actual radiological and laboratory data for confidentiality issues makes teaching contexts more authentic. [8, 11, 12] Developing cases could be an appropriate method by which expert clinicians can put their tacit knowledge into paper and transfer their expertise to novel learners. [13, 14] while developing cases, authors are advised to present it as a story or a narrative, including quotes, using the characters' dialogue as part of the description. [6, 9]
- **Distractors or irrelevant features:** Cases should include relevant information (positive and negative) and unnecessary data to simulate the real challenge of data collection and synthesis that occurs regularly with practitioners. In real-world scenarios, irrelevant information is present, and some relevant essential details can be missing. This can initiate the student inquiry of "what shall I do next?" [5, 6]

However, careful choice of distractors is mandatory to avoid unnecessary complexity. Cases should provoke conflict and, finally, should elicit the need for clinical reasoning and decision-making [8, 9]

- **Gradual disclosure of content:** this is one of the vital and engaging elements of the CBL process. The case should clearly state and illuminate a dilemma without resolving it. [9] Instead of presenting the entire case at once, part of it will be disclosed to students before class. Gradual disclosure helps students to analyze the situation and triggers previous experiences and retained knowledge that might be required to diagnose the presented case.

Gradual disclosure maintains the level of interest and motivation and provides room for student engagement through the creation of areas of decision-making and stages for questioning and feedback[6]

Attribute 3 – Engaging

For cases to be engaging, developers are advised to include:[6, 15, 16]

- Rich and enough content allow varying levels of analysis and interpretation along the continuum of cognitive abilities. [17]
- Opportunities for making their conclusion and engaging in discussions, and defending their opinions[8, 9]
- Points of Feedback, allowing students to receive feedback on their performance during discussions from peers and faculty members is vital. [8, 9]
- Multimedia elements, such as videos, images, or interactive simulations, enhance the case and provide learners with additional opportunities to engage with the material. [6]

Attribute 4 – Challenging

Cases can be made challenging for learners by considering the level of difficulty. Straightforward cases are unlikely to challenge learners or promote critical thinking. [17, 18] Consider designing cases that involve multiple symptoms or conditions, conflicting information, or ambiguous clinical findings. Cases should start with general and allow multiple possible diagnoses and treatment options. Learners should opt to consider different diagnoses and treatment options and be able to weigh their benefits and drawbacks. [6]

After completing the case, learners should be encouraged to reflect on what they learned and how they might apply it in clinical settings. [3, 17]

Attribute 5 – Instructional

Cases used in the CBL process should be educationally sound following the appropriate instructional design by setting objectives that serve clinical reasoning aligned with teaching methods to create an engaging, challenging, and effective environment, and finally aligned with an appropriate assessment plan. [2] Through repeated exposure to a variety of cases with multiple levels of difficulty,

faculty members shall scaffold students in their journey from novice to a general practitioner, build their knowledge and skills, and provide them with a deeper understanding of the concepts to assist them to walk into "the entry to practice level." [6, 8, 9, 15]

2. MATERIALS AND METHODS

We used an interventional quasi-experimental one-group (with no control group) pre-program/post-program design. Voluntary participation in the workshops was open to all faculty members at the surgery and internal medicine departments at the Faculty of Medicine, Alexandria University. 42 voluntary joined and were distributed in 8 workshops Cases were constructed before and after the workshops. The quality of the cases constructed before and after the training was assessed using a modified version of The University of Ottawa CBL development template for quality assurance of the CBL modules. [19]

The original checklist was developed and tested against 18 CBL modules; the authors recommended its use and adaptation according to medical faculties' learning context and nature. It was initially proposed to evaluate online modules. Therefore, our modified version included only some online and technology-enhanced education items. The evaluation legend was adapted and modified by the medical education experts panel to give a quantitative score to the checklist.

At least one case was constructed before and after the workshop by the participants. The same group constructed the cases before and after training. The modified Ottawa checklist was modified to evaluate each case quantitatively. Two medical education experts and an expert matter consultant assessed every case. Each rater assessed each case one month apart for reliability analysis. The mean score derived from the three raters for each statement was calculated, and a paired T-test was run to judge the post-intervention value. Interrater reliability analysis was calculated by Kappa[20] and was interpreted using the scale in **Table 1.**

Table 1: Interpretation of Kappa[20]

Kappa	Interpretation
<0.00	Poor
0.00 - 0.20	Slight
0.21- 0.40	Fair
0.41- 0.60	Moderate
0.61 – 0.80	Substantial
0.81 – 1.00	Almost Perfect

The global scale score was calculated by summing all subscale scores and was interpreted as one construct.

Each statement in the checklist was scored according to the following legend in **Table 2.**

Table (2): Legend for cases assessment by Ottawa Checklist

2= Criteria met
1= Partially met
0= Not met
X =Not applicable

All the constructed cases within the training context had the following nonapplicable items from the Ottawa CBL checklist, which were removed from statistical consideration.

1- Pictures are to be added to help students visualize the appearance/condition. (Excluded from the physical examination section)

2- For special tests, data should be added so students can learn how to do the test and interpret the results. (Excluded from the physical examination section)

3- There was no room to attach relevant pictures in the radiology and special tests sections. (Excluded from the diagnostic tests section)

4- All the cases had no rehabilitation or social aspect being considered. (Excluded from the Management plan section)

After excluding the nonapplicable items for all the cases, the following table describes the items considered in the evaluation. **Table 3.**

Table (3): The Potential score of the modified Ottawa checklist after the elimination of nonapplicable items.

General construct		
Title	2 items	potential score from 0-4
Case divisions	2 items	potential score from 0 -4
Promote critical thinking	2 items	potential score from 0-4
Assessment of part 1		
Case Description	4 items	potential score from 0-8
Assessment of part 2		
Physical examination	3 items	Potential score from 0-6
Diagnostics tests	Lab (3 items)	Potential score from 0-6
Diagnosis and plan	2 items	potential score from 0-4
Global potential score = 36		

Cases were rated by two medical education experts and one expert matter consultant. The need for the expert consultant was a mandate while using the checklist because areas concerned with physical examination and diagnostics required an expert eye. The overall comment on how much the case promoted clinical reasoning was left to the expert matter consultant.

Ethical consideration

- Study procedures were reviewed and approved by the AFM research ethics committee.
- Workshops were conducted under the approval of the vice dean of students' affairs and education, the vice dean of postgraduate studies and research, the head of internal medicine, and the head of surgery departments.
- Implicit consent was taken via WhatsApp. Participants were invited to a WhatsApp group. Study objectives, expected outcomes, and the workshop agenda were shared and explained to the study participants. Acceptance of the invitation and continuity within the group was a measure of implicit consent.
- Faculty members' participation in the study was voluntary.

3. RESULTS

We conducted eight workshops in total, and at the start and end of each workshop, the participants constructed one case. We received 16 cases in total. All cases constructed constituted a maximum of 2 parts. Therefore, the rating for the third part was not applicable.

The construction of cases was limited to the duration of the hands-on activity within the workshop, no follow-ups were sent back, and therefore all cases were of short narrations, a maximum of 20 lines in the post-workshop designed ones. Therefore, assessing the possibility of time management through the designed cases was not feasible. However, post-workshop constructed cases were lengthy (average of 15 lines), while those built before the workshop (average of 8 lines).

3.1 Paired t-test of mean scores of cases constructed before and after training.

All cases constructed before the training lacked a title and was written as only one part, including some information about the patient but needed to be more to create a picture of a real-case scenario. After the workshops, these items were remarkably improved. The mean global scores of the cases constructed before attending the workshops ranged from **15.167 ± 0.408** to a maximum mean score of **20.5 ± 0.548**. In contrast, cases built by the participants after the training had a mean score ranging from (M=24.5 ± 2.51) to a maximum (M=28.167± 1.169). Scores and their mean global score before and after the workshops are further described in **Table 4 and Table 5.**

Table (4): Case Ratings before the workshop using the modified Ottawa checklist

Case number	Medical education Expert 1 global score (Med_edu_1)		Medical education Expert 2 global score (Med_edu_2)		Expert Matter Consultant global score (Expert)		Mean global score. (Mean of 3 raters)
	Pre_1	Pre_ 1^x	Pre_2	Pre_ 2^x	Pre_3	Pre_ 3^x	
1	18	19	17	19	17	18	**18 ± 0.894**
2	20	20	19	20	19	21	**19.8 ± 0.753**
3	19	18	20	18	20	20	**19.167 ± 0.983**
4	16	14	15	14	15	16	**15 ± 0.894**
5	17	16	17	16	17	17	**16.67 ± 0.516**
6	20	19	20	19	20	21	**19.83 ± 0.753**
7	21	20	21	20	21	20	**20.5 ± 0.548**
8	15	15	15	15	15	16	**15.167 ± 0.408**

Table (5): Case Ratings After the workshop using the modified Ottawa checklist

Case number	Medical education Expert 1 global score (Med_edu_1)		Medical education Expert 2 global score (Med_edu_2)		Expert Matter Consultant global score (Expert)		Mean global score. (Mean of 3 raters)
	Post_1	Post_ 1^x	Post_2	Post_ 2^x	Post_3	Post_ 3^x	
1	28	27	26	27	27	28	**27.167 ±0 .7527**
2	26	25	28	25	25	26	**25.83 ± 1.16905**
3	24	22	28	27	22	24	**24.5 ± 2.51**
4	28	26	27	25	26	28	**26.67 ± 1.211**
5	30	28	25	22	28	30	**27.167 ± 3.1251**
6	29	28	29	26	28	29	**28.167± 1.169**
7	25	27	25	27	27	25	**26 ±1.09545**
8	27	25	27	25	25	27	**26±1.09545**

There was a statistically significant increase in the mean scores of the cases constructed after the workshops. The mean increase in the cases' mean score using the modified Ottawa checklist was 8.417, with a 95% confidence interval ranging from -10.54 to -6.29 at $t_7 = -9.375$ and the p-value = < 0.001.

The effect size (r) was calculated using the t-value of the paired t-test through the following equation[21]:

$$r = \sqrt{\frac{t^2}{t^2 + df}}$$

The effect size (r) = 0.96. **(Table 6).** According to Cohen effect size > 0.5 is considered large.[22]

Table (6): Paired T-test for the mean score of the cases constructed

	Paired Differences					t	df	Sig. (2-tailed)	Effect size
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
				Lower	Upper				
The mean of cases constructed before and after training	-8.417	2.54	0.898	-10.54	-6.29	-9.374	7	<0.001	**0.96**

3.2 Interrater Reliability

Inter-rater reliability ensures that different raters provided similar and consistent scores while using the checklists. Inter-rater reliability was statistically significant using Kappa. It was 0.407, indicating moderate agreement between the raters, where $p<0.005$. This suggested that the evaluation process was objective and reliable.

Table (7): Interrater Reliability

		Value	Asymp. Std. Error [a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	**Kappa**	**0.407**	0.196	2.828	.005
N of Valid Cases		8			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

4. DISCUSSION

Faculty members who participated in the workshop were asked to create a case before training and then offered time to construct a new one at the end of the training. This activity was considered the critical step in the experiential design of the FDP and was significant proof of learning in this study.

Case construction in medical education requires specialized skills and knowledge to ensure the case is accurate, relevant, and effective in teaching the desired concepts, Yelon et al.[23] recommended that participants must be allowed to and scaffolded to practice the desired skills in a safe, supportive environment that simulates their actual practice to increase the transfer of learning.

Creating a case library is one of the significant challenges in teaching clinical reasoning using CBL; hence, participants were divided into 2-3 to develop a case scenario before and after training. This process was aligned with the experiential nature of our workshops. Adherence to adult and experiential learning principles is expected to reinforce the workshop's effectiveness, promote participant satisfaction, and contribute to learning transfer beyond the learning setting. This parallels Steinart et al.[24-27] suggestions about faculty development programs.

The Ottawa checklist[19] was proposed in 2018. To our knowledge, the work of Bruner et al. [28] is the only study that used it to assess the quality of cases in CBLin medical education." Gibson et al.[29] used the same tool as a reference for case construction in finance.

Bruner et al.[28] study aimed to review and create a case repository for their institution. Their work is considered a larger-scale study than ours; they conducted it over four years and yielded more cases. With administration support, a case review team was recruited. The team deployed a systematic process by adapting the Ottawa checklist[19] and conceptual framework of instructional cases [6] to build their case catalog. Similarly, our study used the same conceptual framework and revision tool.

In contrast to Bruner et al.[28], in our study, we used a modified version of the Ottawa checklist by adding a rubric to quantify the outcome measures. We justified this because we need a simplified visualization of the difference in mean score variation before and after the training.

After the workshops, cases were remarkably improved. The mean global scores of the cases constructed before attending the workshops ranged from 15.167 ± 0.408 to a maximum mean score of 20.5 ± 0.548. In contrast, cases built by the participants after attending the training had a mean score ranging from ($M=24.5 \pm 2.51$) to a maximum ($M=28.167 \pm 1.169$). There was a statistically significant increase in the mean scores of the cases constructed after the workshops. The mean increase in the cases' mean score using the modified Ottawa checklist was 8.417, and the p-value = was < 0.001. The effect size was >0.5, which is considered large. [22]

The proposed alteration to the checklist allowed us to measure interrater reliability between the three reviewers. Inter-rater reliability ensures that different raters provided similar and consistent scores while using the checklists. This was statistically significant. Kappa 0.41- 0.60 indicates moderate agreement between the raters. This indicated that using the modified Ottawa checklist in the evaluation process was objective and reliable. [20]

5. CONCLUSION

Faculty development programs are vital in facilitating the transition of curricular changes. Case construction is the corner of the success of CBL modules. Appropriate investment should be made by recruiting experts, training, and building a case repository. The modified Ottawa checklist is a reliable tool that can be used to revise cases.

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Declarations

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