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Textbook Evaluation in the Field of Engineering and Applied Sciences: A Development and Application for the use of University-Level Textbook

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Abstract: Textbooks play as the vital tools in many engineering and applied sciences courses and departments. Textbook evaluation checklist was developed in response to the need for university administrators, university instructors and even industry leaders to evaluate textbook materials for their students and potential employees. The current study and textbook evaluation checklist was developed by a review of the recommendation from the current literature review and the qualitative data information from 19 university departmental administrators and instructors in the field of engineering and applied sciences. The current study discusses the improvements made to the textbook evaluation checklist following the completion of the pre-modified textbook evaluation checklist and the semi-structured interview after completing the checklist and providing feedback. The result of this study provides a revised and standardised textbook evaluation checklist for potential readers, university administrators, instructors and industry leaders to select appropriate teaching and learning materials.

Key words: Engineering and applied science textbook, evaluation checklist, learning motivation, textbook evaluation checklist, leaders, evaluation

INTRODUCTION

For decades, the curricula and instruction of engineering and applied sciences in university education relied highly on the lab experiments and mentorship provided by senior peers and instructors. However, textbooks and supplementary materials are also vital tools for students to acquire solid foundation skills and knowledge (theory and practice). While the quality of engineering and applied sciences textbooks and materials have improved in recent decades, decisions regarding the appropriate textbooks to use have become challenging for most mentors, scientists and university instructors. On the one hand, university department administrators and instructors face the pressure of having to select and update their textbooks on a regular basis within a relatively short time period. On the other hand, no one can guarantee that the new uses of textbooks will satisfy student's needs and expectations with regard to knowledge acquisition. In fact, textbook publishers may only provide positive feedback and opinions from former users as one of their highest priorities is to promote the sales rate of their textbook materials. Besides lab experiments and mentorships, textbooks serve as one of the most important tools for building a foundation of knowledge. Therefore, instructors advocate that making appropriate checklists for textbook selection ensures an effective evaluation process.

The role of textbook materials in the engineering and applied sciences classroom: In the current literature database, most of the studies on textbook evaluation tend to focus on the application of textbooks in liberal arts subjects such as language learning (McGrath, 2002). However, engineering and applied sciences learning involves a large number of comprehensive theories and perspectives which are hard to understand simply through lab experiments, discussions and mentorships. Therefore, appropriate textbooks are required, since, it is difficult to provide instruction on some theories to large classes of students, particularly undergraduate students without a solid foundation of subject knowledge (Cunningsworth, 1995).

The use of checklists to evaluate textbook materials in the field of engineering and applied sciences: As evaluating engineering and applied sciences textbooks is demanding, there is a need for an appropriate textbook evaluation checklist that can be widely used. For this short communication paper, the researcher created a

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checklist to evaluate engineering and applied sciences textbooks with the purpose of providing an up-to-date checklist for standardized application for current evaluation and a revisable checklist for instructors who want to enhance the criteria. Although, a large number of checklists have been developed in recent decades, most of them have not focused on application in the field of engineering and applied sciences.

Checklists are one of the effective tools both university administrators and instructors can employ to select and evaluate textbooks and to make decisions on which textbooks to use. As a first-level evaluation, instructors can evaluate textbooks on the basis of recommendations and steps from the checklist. In addition, for the purpose of evaluation, checklists can be beneficial for two groups of school professionals.

First, checklists could help school administrators without significant experience in classroom instruction and industry practices. Some departments rely on recommendations from administrators and upper management for their textbook selection. As these administrators mainly focus on operational management rather than classroom instruction, practical knowledge of classroom curricula and instruction could be neglected (McDonough and Shaw, 2003).

Second, junior university instructors without the significant experience of classroom instruction could benefit from checklists. Whereas senior instructors have teaching experience in various subjects, junior instructors do not (Dos Santos, 2019a). Thus, a checklist would enable them to evaluate the application of textbook materials and develop their teaching strategies and even their classroom management using its recommendations (McGrath, 2006).

Last but not least, there is a need to provide up-to-date teaching and learning materials which can respond to the demands of industry (Tomlinson, 2011). Unlike, liberal arts subjects which do not change significantly, knowledge in the field of engineering and applied sciences can change on a monthly basis. After university professionals have discussed the expectations of industry leaders, both administrators and instructors could evaluate whether or not a textbook's materials correspond to and correspond with industry practices.

MATERIALS AND METHODS

In order to create an appropriate checklist for textbook evaluation in the field of engineering and applied sciences, the researcher considered three factors:

- Review of the current textbook evaluation checklists
- Consultation with feedback and opinions from university administrators and instructors in the field of engineering and applied sciences
- Create points to consider in producing engineering and applied sciences materials

Previous studies on checklist development mainly focus on the field of the liberal arts and language learning. Checklists for engineering and applied sciences are hard to locate. In order to gather data information, a qualitative method was employed.

First, the researcher collected a large number of textbook checklists to serve as blueprints and background. However, most of the recently developed checklists focus on the field of language learning. The researcher needed to revise these checklists in order to develop a checklist that corresponds to expectations in the field of engineering and applied sciences.

Second, the researcher invited 19 engineering and applied sciences university administrators and instructors to share feedback and opinions. Five of the participants were departmental administrators; the remaining 14 participants were university instructors with a doctoral degree in the field of engineering and/or sciences (i.e., two lecturers, eight assistant professors, three associate professors and one full professor). All 19 participants were individually provided with a copy of the checklist (i.e., the revised checklist from the first step of the study), a statement of the purpose of the research, a participation agreement form and a link to a comment forum to provide feedback and opinions (Merriam and Tisdell, 2015). The participants had to review at least three textbooks (of any level or standard of difficulty) that they were currently using in their department (Dos Santos, 2019b).

Third, all the participants were invited to participate in a face-to-face and one-on-one semi-structured interview after completing the checklist and providing feedback (Creswell, 2009; Tang and Dos Santos, 2017). All the participants returned their checklist within 2 weeks and attended an interview within 1 week.

RESULTS AND DISCUSSION

Considering the recommendation offered by Dos Santos (2016), the researcher gathered criteria in order to develop an up-to-date checklist for the field of engineering and applied sciences. As no checklists for the field of engineering and applied sciences are available in the current and recent English-language database, the researcher first had to collate the elements and factors that are significant in the field of engineering and applied sciences in order to revise Dos Santos's checklist for language learning. One of the features of the checklist compiled by Dos Santos (2016) is its employment of the Likert-scale score system, the current checklist also

employs a similar system (i.e., 5-excellent, 4-good, 3-neutral, 2-poor, 1 lack of knowledge) in order to rate the effectiveness of textbooks. Most importantly, Dos Santos concentrated on textbooks being an appropriate match for instructors, students and the curriculums. All of the factors are vital as instructors aim to employ textbooks to improve the learning experience. With regard to structure, the current checklist is made up of four sections; content, exercises and activities, applications of the subjects and transferable skills.

Added criteria: Some criteria were added to the checklist on the basis of the feedback and opinions provided by the participants. These criteria included the application of visual illustrations; pictures; answers for questions; examples, of challenging mathematics equations; case studies; readings on subject history; background on the engineering and applied sciences fields; Internet exercise websites; online access code and further reading and supplementary materials. It is worth noting that all but one of the participants believed that visual illustrations and pictures were the keys for increasing knowledge and understanding, particularly for students in the fields of biomedicine, chemistry and physics. One participant further, explained that if no clear visual illustrations were presented, lower-level students without lab experience would not be able to understand the colors and mixtures of the chemical elements.

Removed criteria: The removal of two criteria, price and online version was recommended as they were not considered important to the subject. All 19 participants believed that price should not be a consideration in assessing the quality of textbooks. Several of the participants shared similar ideas about "quality being better than quantity in a textbook". Therefore, the researcher decided to remove these two criteria. The revised checklist and the feedback and opinions from engineering and applied sciences professionals are presented in appendix A.

CONCLUSION

This study summarised the previous study conducted to develop and evaluate a university-level textbook materials checklist. However, as a large amount of the related literature on checklists in the current database is mainly concerned with the fields of liberal arts and language learning, the researcher developed the current textbook evaluation checklist for the field of engineering and applied sciences.

In addition to reviewing the literature (Dos Santos, 2016), the researcher also collected feedback and opinions from professionals in the field of engineering and applied sciences. The checklist developed in this study can assist professionals in this field to gain a good understanding of the available textbooks and to locate the most appropriate textbook materials for their students. The current checklist was revised on the basis of the feedback and opinions.

IMPLICATIONS

The study has effective practical implications for university administrators and instructors who are interested in evaluating their textbooks, particularly in the field of engineering and applied sciences. Accordingly, this study provides three recommendations.

First, as textbook checklists are not widely used in the field of engineering and applied sciences, this checklist is one of the first of its kind. Therefore, further addition or removal of criteria is essential for in-depth development.

Second, as each department, subject, field and country has its own features and characteristics, one checklist cannot satisfy all needs and expectations. Therefore, professionals could revise the checklist on the basis of their own needs.

Last but not least, industry professionals could become involved in the development of the checklist and be interviewed about their opinions. Students need to enter the workforce after graduation from university. The training and knowledge they gain at university should meet the actual needs of the industry. Therefore, industry leaders should be invited to give their opinions, so as to create wider perspectives and inform future developments.

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Appendix A: Textbook materials evaluation checklist in the field of engineering and applied sciences

Textbook materials evaluation checklist

Textbook title: (5-excellent, 4-good, 3-neutral, 2-poor, 1-lack of knowledge)

5 4 3 2 1

First section; content:

1. The organization matched with the curriculum.
2. The objectives of the textbook are specified described.

3. Summaries of each chapter and subject are described.
4. The technical languages are simple and easy to understand.
5. The learning outcomes are outlined.
6. The content is up-to-date.
7. The content is related to learner's knowledge-based.
8. The materials are in order.
9. The materials offer visual illustrations for description.
10. The materials offer colorful pictures to outline the essential materials. (e.g., chemical elements)

Total score of this section

Second section; the exercises and activities:

11. Exercises for each new knowledge is outlined.
12. The materials offer appropriate case studies.
13. The materials offer appropriate supplementary teaching and learning materials at the appropriate level.
14. The materials offer appropriate supplementary teaching and learning materials which challenge the critical thinking of the learners.
15. The materials offer answers and progresses for each question and exercise.
16. The materials offer enough compulsory and further reading for the subject history.
17. The materials offer appropriate backgrounds and industry developments for the subject matter.
18. The materials offer easy to access smartphone applications to access outsides of the classroom environment.

Total score of this section

Third section; the applications of the subjects:

19. The exercises and case studies are applicable to the industry needs.
20. The activities recommended for practicing the knowledge are enough.

Total score of this section

Fourth section; transferrable skills:

21. The learners can transfer the knowledge into multiple subjects.
22. The learners can apply the knowledge to upper-level/ advanced-level courses.
23. The learners can enhance and re-practice their previous knowledge into the current textbook materials.
24. The materials allow the learners to apply and transfer inter-disciplinary knowledge into the current textbook.

Total score of this section

Total score of this textbook material:

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