A comparative analysis of examples used in textbooks between the United Kingdom and China

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This research is devoted to analysing the examples used in textbooks from two countries. The aim is to give suggestions for teachers who work in bilingual schools, to choose the advantages of each of the two countries' textbooks to facilitate recent Chinese students' learning efficiency in bilingual mathematics lessons. Six criteria are included in the analysing framework for comparing five topics selected from two countries' textbooks. Five bilingual teachers are invited in the interviews to express their attitudes toward the two textbooks after they read the comparison results. This study suggests that except from using extra examples to strengthen students' exam questions-solving ability, the UK's textbooks can be used as mainstream textbooks due to the final examination, whereas the Chinese ones could be a supplement for learners in early ages and for quick learning of high-attaining students or as an expanding of leading students to appreciate mathematics.

Keywords: comparative analysis; secondary mathematics textbooks; use of examples

Introduction

I was a teacher in an international school in China. Most of the students in my school are Chinese, but they are required to take English mathematics examinations when they graduate. They have to experience a process where they move from a Chinese mathematics class to an English mathematics class. Textbooks are also changed in this process. I observed a conflict between Chinese mother tongue and acquired mathematics in English for students. More importantly, different mathematics textbooks have different characteristics. Accordingly, I decided to examine the advantages of each of the textbooks in order to facilitate teaching and learning efficiency in the bilingual mathematics class. There are a lot of aspects which can be compared (e.g. definitions, cultural background, mathematics proof, etc), but it is unrealistic to involve every aspect to compare the two textbooks in one study. From my perspective as a teacher, I think teaching mathematics incorporates the use of examples in almost every class. Examples play a central role and the use of examples is a necessary part in mathematics teaching (Bills et al., 2006). In other words, an example is like a bridge which links an unknown abstract concept and a more complete understanding of knowledge (Zhang, 2019). Therefore, I make a comparative research of examples used in textbooks between the UK and China.

Method

The method of this research is qualitative. A comparative framework is designed for analysing five topics from mathematical textbooks of different ages (detailed in table 1). The Chinese textbooks are selected from People's Education Press whose textbooks are the most widely used version in China. However, there is no specific mainstream textbook used in the UK, so I selected the free online versions for the public that are available to anyone. Among the UK's textbooks, the three topics between Year 8 and Year 11 were selected from the texts of Mathematics Enhancement Program, and the two topics in Year 12-13 were selected from the text of Oxford University Press. The comparison results will be used in interviews to collect bilingual mathematics teachers' views about the two textbooks.

Mathematical topics

Five topics were chosen for comparison according to students' ages. In order to make comparison more rigorous and objective, the selected topics are those learned by the two countries' students at the same age. Moreover, different fields of mathematics are considered (algebra, geometry and statistics). The following five topics were selected at the age from 13 to 18 (table 1).

Topics		Age
'Straight Line Graphs'	平面直角坐标系	13 (Year 8 in the UK and Grade 7 in China)
'Linear Graphs and Equations'	一次函数	14 (Year 9 in the UK and Grade 8 in China)
'Angle Geometry'	圆/相似	15-16 (Years 10-11 for GCSE in the UK and Grade 9 in China
'Probability'	统计/概率	17-18 (Years 12-13 for A-level in the UK and Grades 11-12 in China)
'Algebra'	函数	

Table 1. Topics selected comparison between the UK and Chinese textbooks

Comparative framework

The comparative framework is a new theoretical synthesis. A number of scholars have performed comparative research or textbook analysis and the process of designing my own research framework has consisted of the selection, theoretical integration and extension of ideas from these existing studies.

My comparative framework consists of six criteria. The main body (first five criteria) is summarised by Zhang (2019) who used it as the comparative framework for his research. Firstly, *sequence of examples*, is used to analyse the knowledge points' construction and the development of difficulty. Secondly, *the number of solution methods*, within the 'solution example part', which guide students in different ideas to solve a problem. Thirdly, *diagrams and stories*, which are used for discovering the cultural background and learning atmosphere which is situated for the students. Fourthly, *language expression ways*, used to analyse the differences by comparing grammatical change and the words used which are more instructional or exploratory between textbooks. Fifthly, *specialisation of words*, used in my framework to reflect the textbooks' author's expectations of teaching which tends to be highly specialised or not. Finally, *examples' focuses*, which looks to reflect the focuses of instructional content, which shows the differences of specific teaching focuses between the two textbooks under a similar topic. These six criteria consist of my analysis framework which utilises the criteria of Charalambous, C. Y., Delaney,

S., Hsu, H. Y., & Mesa, V. (2010), and some ideas from Morgan (2005), Zaslavsky (1991), Bishop (1994), Alshwaikh and Morgan (2014) and Yang (2014) (Table 2). Although Charalambous et al's. (2010) criteria are helpful for the composition of my framework, I have chosen not to utilise that framework in its entirety, for example, I have not utilised the criteria 'presentation of the rules or the steps' since exploring the rules or steps illustrated from the examples would require input from students, which was not available to me in this study. So, this criterion (and its quantitative method) was not be used in this study, but it could be extended to future work.

Criteria	Roles	Source	
Sequence of examples	Analysing the mathematics construction in textbook and development of difficulty	Charalambous et al. (2010); Erbas et al. (2012)	Summarised in Zhang (2019)
The numbers of solution methods	Whether the textbooks are committed to giving students more ideas to solve questions	Charalambous et al. (2010); Stenmark (1989); Lajoie, (1995); Silver & Kenney, (1995); Yackel & Cobb, (1996); Boaler, (1998); Stigler & Hiebert, (1999); Li (2000)	
Diagrams and Stories	Exploring cultural background and learning atmosphere which is situated for students	Charalambous et al. (2010); Morgan (2005); Zaslavsky (1991); Bishop (1994); Li (2000)	
Language expression ways	Finding grammatical change in how the person using the textbooks is addressed and the absolute degree of use of words	Morgan (2005)	
Specialisation of words	Reflecting editors who hope teaching tend more to highly specialised or not	Alshwaikh and Morgan (2014)	
Examples' focuses	Reflecting the focuses of instructional content to show the differences of specific teaching focuses under the similar topic	Yang (2014)	Added in this study

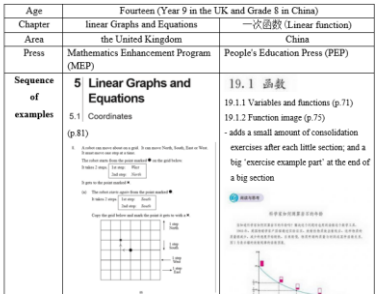
Table 2. The comparative framework developed and used in this research

Interviews

The interviews were arranged after the comparative results had been completed. Compared with questionnaires and other methods of data collection, interviews have the advantage of providing greater depth in the case (Cohen, Manion, & Morrison, 2007). Furthermore, individual interviews are the most ideal choice in order to get more in-depth feedback (Kvale, 1996).

The interview had three segments and the design of the questions was based on the principle of moving from general to narrow and finally to specific (Cohen et al., 2007). First, a general question was asked in order to gauge the understanding of the particular teacher's students' mathematics and English attainment. Students' attainment level leads to the different examples showed by teachers in the lessons. That is why some schools set different levels of classes within the same age-group. Next, the questions were narrowed to focus on the textbooks, specifically, the advantages of examples from each of the two textbooks, in order to establish these details from the different teachers' perspectives. Next, specific to the selection of textbooks, teachers were asked which textbooks they preferred overall and why. The content of interviews was recorded. In analysing my data, I use a grounded theory approach so that the bilingual teachers' ideas were generated from the data (Cohen et al., 2007). I coded the data first and then categorised through comparing the similarities and differences of their keywords. (Ryan & Bernard, 2003). These categories are used to discuss the textbooks' selection and use by combining them with my comparison results.

Results



Age	Fourteen (Year 9 in the UK and Grade 8 in China)	
Chapter	linear Graphs and Equations	一次函数 (Linear function)
Area	the United Kingdom	China
Press	Mathematics Enhancement Program (MEP)	People's Education Press (PEP)
Sequence of examples	5 Linear Graphs and Equations 5.1 Coordinates (p.81)	19.1 函数 19.1.1 Variables and functions (p.71) 19.1.2 Function image (p.75) - adds a small amount of consolidation exercises after each little section; and a big 'exercise example part' at the end of a big section

Figure 1. Example of the comparison work

UK/*China*	Year 8/*Grade 7*	Year 9/*Grade 8*	GCSE/*Grade 9*	A- level/ *Grade11-12*	A-level/ *Grade11-12*
Sequence of examples	Start with a review section. *Directly teach new knowledge points.* Hardly appear real life issues. *Taking the*	Start with a review section. *Directly teach new knowledge points.* Hardly appear real life issues. *Taking the*	Start with review sections. *Directly teach new knowledge points.* Hardly appear real life issues. *Start and end*	Directly teach new knowledge points. From basic knowledge of index and logarithm, to the polynomial. *Start with a review section. Then begin with knowledge of*	No specific review section; from basic concept of probability to further conditional probability and probability involving premutation and

Figure 2. Part of summary table

There are tens of pages of research results (e.g. figure 1) and a summary table (e.g. figure 2) as the comparison results, which analysed the similarities and differences of the examples from the two countries' textbooks according to the specific topics, criteria and ages. Basically, for the sequence of examples, the UK's textbooks focus more on direct teaching knowledge points and develop the knowledge points on the theoretical level, while Chinese textbooks pay more attention to linking the knowledge points with real-life. For instance, the UK's textbooks always refer to theory (e.g. figure 3) whereas Chinese textbooks begin with examples in life (e.g. figure 4) and ends with application examples (e.g. figure 5).

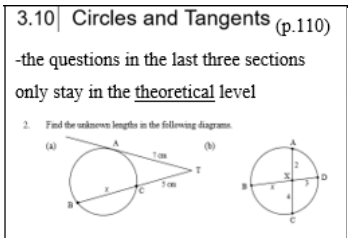


Figure 3

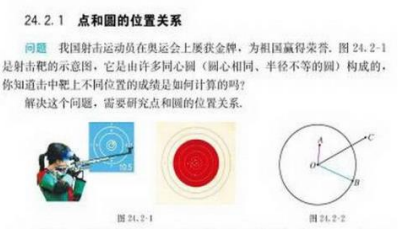


Figure 4

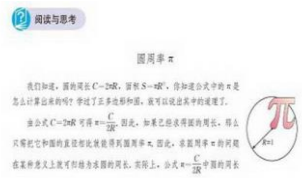


Figure 5

For the variety of solutions, the UK's ones do not pay much attention to using different ways to solve a question for younger students, although this increases with increasing ages. In contrast, the Chinese textbooks present more alternative solutions for younger students but this decreases with increasing ages. For the diagrams and stories, the UK's textbooks almost all use theoretical diagrams and have a few background descriptions of mathematics applied to real-life, whereas the Chinese textbooks always include some background stories with real-life and their diagrams are not only limited to the theoretical level. For the language expression ways, the UK's textbooks state content in an objective way and hardly use personal pronouns, as if from a 'bystander' perspective, while the Chinese textbooks prefer to apply and often switch between personal pronouns from the perspective of 'a member in learners' group'. However, both textbooks indicate that students' learning should change from simple accepting to exploring and judging by themselves (demonstrated by the use of language from instructional words to exploratory words with increasing ages). For the specialisation of words, the two countries' textbooks both use highly specialist language, and this is the only item for which results are the same. Finally, for the examples' focuses, although they still have many differences in each topic, generally, the UK's examples are straightforward and move into deeper mathematical theory, whereas the Chinese examples are closer to teaching mathematics by moving between theory and real life.

Discussion

All content of comparison results was presented to five bilingual mathematics teachers. The interviewees show their own different viewpoints respectively, but there is still some consensus. First of all, the comprehensive learning attainment and mathematical English of students is of concern to bilingual mathematics teachers. They talk a lot about the relationship between students' attainment and their test scores. Some teachers' students are 'good in mathematics and weak in English', they can get to make progress gradually and most of them can get a good result before graduation. In contrast, some teachers' students are more 'good in English and low in mathematics'. They are difficult to support in getting a good grade at the end of the course. The reason may be that the former only needs to increase mathematical English vocabulary and understanding ability in mathematical English, while the latter need to make a breakthrough in understanding mathematics whether in English or Chinese. Secondly, the UK's textbooks are more straightforward and more simple, they do not include application and instead do the theory (feedback based on items 'sequence of examples' and 'example focuses'), whereas the knowledge development of Chinese textbooks moves between theory and application ('the numbers of solution methods', 'diagrams and stories' and 'language expression way'). In this case, the Chinese textbooks seem to be advantageous for high-attaining students to have efficient learning, but it could be less helpful for students who are lower-attaining in mathematics. Instead, the UK's textbooks are a better choice since they provide students with a detailed scaffolding set to understand concepts on an individual basis. Finally, all of the interviewees think English mathematics textbooks should be the main teaching material, because the students need to learn and express mathematics in English in their final examination. This choice does not mean that language is the only reason. Some teachers think if Chinese mathematics textbooks can translate in English, they would like to use Chinese ones and some of them propose the ideas about using Chinese textbooks as supplementary teaching materials, other teachers persist they prefer to use the UK's textbooks because it has a clearer knowledge content structure. Hence, this point is merely their consensus rather than indicative of their full reasoning.

Conclusion and Future research

By comparison, the UK's textbooks are more straightforward and clearer in terms of knowledge content structure, which supports an effective scaffolding for learners. The UK's textbooks are easier for students to understand mathematics especially for middle and low attainment students, and hints are given to help students follow. In contrast, Chinese textbooks usually link theory and real-life together to teach students, only mentioning foundational knowledge briefly. Chinese textbooks include more information in an example and imply an objective to explore mathematics with students together, regarding students as high attainers and so are potentially more suitable for those high attaining students. In the selection of teaching materials, basically, in addition to using extra examples to strengthen students' examination question-solving ability, the UK's textbooks can be used as mainstream textbooks in preparation for the final examination, whereas the Chinese textbooks could be a supplement for learners in early ages and for quick learning of high-attaining students or as an expanding of leading students to appreciate mathematics.

There are two directions that I would like to take my research further. Firstly, I would like to find the teaching effectiveness of examples from textbooks and the effect of combining the two textbooks in real lessons through making an assessment for students and quantitative analysis. In addition, based on the examples' comparison from textbooks, I would like to find the influence of different textbooks on students' mathematical thinking.

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