THE DEVELOPMENT OF TEXTBOOKS ON MATHEMATICS FOR SENIOR HIGH SCHOOLS WITH RESPECT TO A TECHNOLOGICAL VISION FOR BUILDING INTEGRATED MATHEMATICAL CONCEPTS LEADING TO AN INDUSTRIALIZED ERA

Riyanto
Agus Susanta
and
Fanani Haryo Widodo
University of Bengkulu, Indonesia

The objectives of this research is to develop a handbook for writing textbooks on mathematics for senior high schools with respect to a technological vision and some exemplar textbooks associated with the handbook. The hypothesis of this research is that mathematics textbooks with respect to technological vision are assumed to be able to motivate students to study mathematics better and to improve in their results. The hypothesis has been proved by carrying out developmental research consisting of three major stages: analysis of need, designing the handbook for writing textbooks and the completion of corresponding mathematics textbooks. This research has been carried out for three years since April 1999. The research done in the first year (1999/2000) has resulted in the drafting of the handbook for writing mathematics textbooks and the drafting of the corresponding mathematics textbooks for Years 1, 2, and 3, and also for the 1st and 2nd quarters for use in the four cities. For the second year (2000) the results are the edited draft of the handbook for writing the mathematics textbooks and the edited draft copy of the corresponding mathematics textbooks for Years 1, 2, and 3, and also for the 1st and 2nd quarters for use in the four cities. These edited draft copies of the mathematics textbooks are the results of the tryout of the previous drafts to some small groups of four senior high schools in each of the four cities. In general, most students have found the mathematics textbooks to be satisfactory.

Keywords: Mathematics, textbooks, senior high schools, technological vision, integrated mathematical concepts, industrialization.

INTRODUCTION

In the basic sciences, mathematics has a strategic position as a tool to combine and develop a system of new knowledge. Mathematics education is essential in terms of technological development for industrialization as a stage for National Development. However, the data from the Original Evaluation Result (Nilai Evaluasi Murni (NEM)) does not support the program of the National Education Department (Depdiknas).

For example, the data from the NEM for graduates of senior high schools nationally are very low (see, Djoyonegoro, 1999; Kompas, 1996; Gatra, 1996), while for graduates of senior high schools in the Province of Bengkulu the data are the lowest from 1996/1997 to 2000 (Kanwil Depdiknas Bengkulu, 2000). Another factor that causes students to fail in understanding mathematics is that the mathematical concepts taught in senior high schools tend to constitute abstract formulas which do not consider applicable aspects that link and match with the need of technological development. Mathematics becomes a subject that is boring, difficult, and cheerless. It appears, the course of mathematics in senior high schools must cover technological visions.

Learning is interaction between learner and sources of learning (teachers, textbooks, appropriate media). Among sources of learning, textbooks play an important role in the process of learning since textbooks are used as guides for teachers to teach students. Even students use textbooks as guides to learn mathematics. Textbooks need to be designed based on the theories of learning, experiences of teaching, and results of researches so that students and teachers can readily understand the concepts and principles of mathematics. Moreover, in writing textbooks it is also necessary to consider the level of the students' thinking abilities, experiences of students, the environment of students, and the intelligence of students. These are necessary since mathematics is abstract, structurally logical, systematic, consistent, and demands creative, critical, and innovative competencies. Based on the essence of learning mathematics, explaining mathematical concepts through textbooks needs examples on the application of concepts to real life situations and technological development and on solving technological problems as well as hinging on to models and solutions of daily life problems. The textbooks are also accompanied by figures, photos,

challenging and interesting graphs on consideration of the dimensions of the brain. The characteristics of left brain are for logical, sequential, linear, and rational thinking. Its way of thinking is suitable for verbal expression, editorial association, phonetics, orderly assignment and symbolism. Some examples for such assignment are writing, reading, and other assignment stressing to detail and fact. However, the left brain can also interpret abstract and symbolic thought (DePoster & Hernacki, 1992; Spriger & Deutch, 1997). On the other hand, the right brain's way is characterised by random, disorderly, intuitive, nonverbal and holistic thinking. The right brain has creative potency that encourages student's intelligence although less people give it attention (Mulyadi, 2000). This research tries to take optimal advantages of the right brain.

The use of the right brain in studying mathematics is carried out by showing comprehensively mathematical concepts together with interesting illustrations and mathematical problems that motivate students to think creatively. Integrated mathematical concepts are mathematical concepts integrating inter-concepts in mathematics and inter-concepts between inner- and outer mathematics. Included in this integration is integrated learning. Such textbooks are called "Real Life Mathematics"— mathematics involving other fields and daily activities (Schwartz & Curcio, 1999).

Briefly it can be reported in the first year of this research that textbooks on mathematics under technological visions are entitled "Mathematics In A Real Life" and arranged in these ways: organize contents and correlate these inter-concepts in mathematics as well as those between "inner" mathematics and "outer" mathematics especially with applied field concepts so that the textbooks may broaden the technological vision of students who read them; complete and lay out figures, photographs and graphs in order to make it easy for students to understand concepts and enhance the students' interest toward mathematics; give examples on the application of concepts in order to make it easy for students to understand integrated mathematical concepts; and model real problems mathematically in order for them to be able to be used for solving daily problems.

The facts related here indicate that textbooks on mathematics are published according to the authors' interest and competence so that in terms of quality the writing of the textbooks is less controllable (Suyanto, 1996;

Swita, 1998). Sometimes due to the authors' wishes and interests, teachers and students face difficulties learning mathematics. The aim of this research was to develop textbooks on mathematics for Senior High Schools (SMU) with respect to technological visions in order to make them easy for students to understand integrated mathematical concepts. In addition, this study may support the Higher Education Directorate's program to increase the proportion of exact sciences and social sciences in higher education where graduates are expected to be ready to compete in the industrial world.

From the research done in the first year, the main question was to find out how effective the textbooks were on real life mathematics for students when these textbooks are measured by the degree of ease, appeal, challenge and encouragement for students to broaden their technological vision. Therefore, the main problem in the second year of the research can be formulated as follows: (1) how to design a format of validation, (2) how to design questionnaires for students, (3) how to validate the suitability of textbooks, (4) how to examine the suitability of textbooks for small groups, (5) how to write effective guide books for writing textbooks when used to write mathematics textbooks, (6) what are to be the quality of corresponding mathematics textbooks in terms of the ease for teachers, students, and experts to understand.

Hence, the hypothesis proposed in this research was that textbooks on real-life mathematics were estimated to be able to improve the enthusiasm of students to learn mathematics and improve their learning so that the graduates of Senior High Schools (SMU) have better competence in mathematics with respect to a technological vision.

RESEARCH METHOD

To prove the hypothesis the authors used a developmental research approach consisting of the activities of need analysis, designing the handbook for writing textbooks and the textbooks, and evaluation of the handbook for writing textbooks for the textbooks. The research design comprised of a survey, content analysis, action research, and an artificial experiment. This research had been intended to be completed in three years, commencing in April 1999, and will be completed by December 2001.

In the first year (1999/2000), this research was conducted through five stages. The results comprised of data from questionnaires for determining how far the students acquaint themselves with social-cultural activities, draft the handbook for writing textbooks and the corresponding textbooks for Years 1, 2, and 3, 1st and 2nd quarters, and used in the four cities. The draft had been reviewed and presented in a seminar in BPPT Serpong on November 1999.

In the second year, this research was conducted by perfecting the draft of the handbook for writing textbooks and the corresponding textbooks, designing the format of validation and questionnaire of evaluation for students, and validating and trying out the textbooks. Editing the draft of the handbook for writing textbooks was necessary since it had not been effective as a guide for writing textbooks especially its procedure in writing. So far, the procedure had not been able to develop the role of the right brain optimally. Therefore, in the draft of the handbook added a stage on challenging applied exercises. The method used in this step was to source into the literature review. On the other hand, a revision of the textbooks was conducted to follow consistently the handbook and to complete the examples, and creative exercises, to include interesting and colourful pictures as well as applied exercises related to daily activities with respect to the local culture. The theme of social-culture was used at the third level consisting of physical materials. The fourth level of social culture such as values and norms, were shown through proverbs and the use of historical stories on inventions.

The instrument of validation for the textbooks was designed according to the procedure of writing mentioned in the edited handbook. The arrangement of the questionnaires for students to evaluate the quality of textbooks was written based on the degree of clarity, interest, ease of use, motivation, creativity. Both the instruments for validation and questionnaires were used by teachers, students, and experts to evaluate the textbooks. The validation was performed by sending the textbooks to mathematicians and mathematics teachers as "the users" and this was sustained by discussion. The textbooks had been sent to six mathematics teachers of Senior High Schools in Bengkulu, six mathematics teachers of Senior High Schools in Jayapura, six mathematics teachers of Senior High Schools in Makassar, and six mathematics teachers of Senior High Schools

in Jakarta as well as to two experts on mathematics education. The tryout of textbooks was given to students in Grades 1, 2, and 3 for one quarter of the term due to the school holidays. The method used in this step was class action research. The tryout for small groups had been done in November 2001 in three schools: SMU, Jakarta, SMU, Makassar, and SMU, Jayapura, and on July 2001 in SMU, Bengkulu.

The arrangement of the validation format was carried out after the guide book had been revised. The initial step of the arrangement was the outlining of points containing variables and sub-variables. The variables were obtained from the structure and steps of writing mentioned in the handbook. Furthermore, the criteria of the validation format can be determined. There were four criteria as follows: very good, good, fair, and poor. This format was used by experts and teachers as a guide for evaluating the textbooks. Moreover, the textbooks were evaluated through four criteria accompanied by four measurements as follows:

Table 1
The criteria used for measurements by experts and teachers

Poor	**Fair**	**Good**	**Very good**
1 - 1.55	1.56 - 2.55	2.56 - 3.55	3.56 - 4.0

The questionnaires for evaluation by students were arranged according to the levels of ease, clarity, motivation, appeal, and creativity. Based on those points, the criteria were determined according to four classifications as follows: very good, good, fair, and poor. These questionnaires were used to evaluate the textbooks by the students as the main users of the textbooks. The relevant points raised were made in an elementary way in order to answer the questions for the students without boring them. In addition, the quality of the textbooks could be measured using the criteria below:

Table 2
The criteria for measuring the textbooks by the students

Poor	**Fair**	**Good**	**Very good**
1 - 1.55	1.56 - 2.55	2.56 - 3.55	3.56 - 4.0

In the third year, beginning in 2001, this research constituted the stage for completion and tryout of the textbooks to a large number of groups of students in order to know their effectiveness. The tools for collecting data are questionnaires, interview, observation, and tests. Moreover, the data analysis was carried out by using descriptive argumentation and quantitative analysis (Analysis of variance (ANOVA)).

RESULTS AND DISCUSSION

Results

In this research the authors obtained two kinds of data: the data for evaluation from experts on mathematical education and mathematics teachers and the other set of data from the students. The former were the evaluation on the draft of the handbook for writing textbooks and the draft for the corresponding textbooks, while the latter were the data of evaluation for the textbooks, the level of ease, clarity, appeal, motivation, interest, and creativity of students of Senior High Schools in Bengkulu, Jakarta, Makassar, and Jayapura. The results obtained are classified thus:

Effectiveness

The literature review and tryout results for the handbook for writing textbooks need to be improved, especially on the Table of Contents. In the Table of Contents it is necessary to add "challenging applied exercises" in order to encourage creativity and to broaden the vision of students on technology and social-culture. In addition, improvement on the layout of figures and graphs was necessary to make the textbooks more interesting and challenging. All these had been done by March 2000.

Quality

Although the textbooks on real-life mathematics had been written by referring to the revised handbook, there were difficulties to find examples corresponding to culture. For culture certain artifacts, objects or tools were included. For example, for cultural activities such as *Tabot, Asmat dance, Kecapi* music, and *Ondel-ondel* were used as objects or tools to talk about the number of attendances. The cultural aspect in this research was limited at the third level. Furthermore, at the fourth level of culture for values, norms, and sensitivities were shown through proverbs and historical stories on

inventions. So far in this research the students had not been involved deeply in the fourth level of culture. It was estimated that the involvement of the fourth level of culture in mathematics textbooks would build a generation that is intelligent, creative, and possess good character.

Validation

According to two experts on mathematical education, the handbook for writing textbooks was very useful. Nevertheless, they proposed little change in the titles of the textbooks by merely adding the word "in" *(dalam)* in the original titles. In addition, the drafts of the corresponding textbooks were validated by the same experts as those for the handbook and the 16 mathematics teachers. The results are as follows:

Validation by experts

In general, the experts on mathematics education stated that the textbooks were good, but they gave some comments such as on the use of the same terms for the textbooks for Years 1, 2, and 3, the choice of difficult words, the numbering of figures, mistyping, and the inconsistencies of some chapters in the textbooks with the National Curriculum. Briefly, the results of the evaluation on the textbooks by the experts can be seen in Table 3 below:

Table 3
Result of evaluation on textbooks by experts

Expert	**1st grade**	**2nd grade**	**3rd grade**
I	3 (good)	2.8 (good)	3.2 (good)
II	3.1 (good)	2.57 (good)	2.78 (good)

Validation by teachers

Based on the evaluation by the 16 mathematics teachers of the Senior High Schools for the textbooks for Years 1, 2, 3 it can be said that the textbooks were suitable although they still have some improvements to be made. These improvements include: (1) the textbooks for Year 1 are not so interrelated with other fields, too brief elaborations, and fewer number of inquiry and developed technological examples; (2) the textbooks for Year 2 need to have numbers for the figures, to clarify the inquiry questions, to improve the summaries, and to have colour for the pictures; (3) the textbooks

of Year 3 need to give more examples of applied problems in technology, to simplify the examples of problems, to number figures, and to simplify the language in order to be easy to understand. Moreover, the same suggestions for all the textbooks are that they need more pictures or figures that are suitable in familiar situations. Concisely the results of evaluation by the teachers to the textbooks are shown in Table 4 below:

Table 4
Result of the evaluation on textbooks by teachers

City	1st grade	2nd grade	3rd grade
Bengkulu	3.30 (good)	2.68 (good)	2.52 (fair)
Jakarta	3.00 (good)	2.47 (fair)	2.66 (good)
Makassar	3.20 (good)	2.22 (fair)	2.24 (fair)
Jayapura	3.40 (good)	2.80 (good)	2.35 (fair)

Tryout

Based on the results of the tryouts, in general, students viewed the textbooks on mathematics for better technological vision as suitable. Nevertheless, the textbooks for Year 2 were classified as being fair by students of Senior High Schools in Bengkulu while the textbooks for Year 3 were categorized into being fair too by students of Senior High Schools in Jakarta and Jayapura. In addition to these results, some students commented that students had difficulty to understand the language used in the textbooks, the textbooks needed additional exercises, the figures or pictures needed to be coloured, teachers still had difficulty to understand the exercises so that the students had the same difficulty. Table 5 below shows the results:

Table 5
Result of the evaluation on textbooks by students

City	1st grade	2nd grade	3rd grade
Bengkulu	2.84 (good)	2.49 (fair)	2.70 (good)
Jakarta	2.80 (good)	2.57 (good)	2.42 (fair)
Makassar	2.64 (good)	2.61 (good)	2.61 (good)
Jayapura	2.92 (good)	2.65 (good)	2.50 (fair)

Considering the inputs given by the experts, teachers, and students, the research in the third year has been directed to perfect the textbooks so that students are able to understand easily and be fond of the textbooks. It was expected that by the end of the third year of research the textbooks will be appreciated by the students. However, some students have found pleasure in the textbooks and therefore this approach of having suitable textbooks need to be sustained.

DISCUSSION

Writing the handbook for writing textbooks and writing the corresponding textbooks are reciprocal processes. The change in the handbook should be accompanied by a revision in the textbooks while the change in the textbooks can cause inconsistencies with the handbook, since the textbooks are the outputs of the handbook. Therefore, the revision must be carried out on both the handbook and the textbooks comprehensively and compromisingly. Improving the textbooks must not be to degrade the handbook and vice versa the improvement of the handbook should not affect the textbooks.

Based on the results, in general, it can be stated that the handbook and the textbooks obtained consequently were very good responses respectively. The former was carried out by two experts on mathematics education, while the latter were given by the experts, teachers, and students in the senior high Schools. By editing both the handbook and the textbooks in order to improve them, it is expected at the end of the third year for the research, both the handbook and the textbooks will be suitable. In the third year this research focused on editing the textbooks. The problem was how to improve the textbooks without lessening the comments for the handbook.

Some important points that can be mentioned from the evaluation are the colour of the textbooks and the instruments of the evaluation by the students. Regarding the tryout in Year 2, the textbooks given to teachers and students were not colourful since all the textbooks were just photocopies. This caused the teachers and students to be not interested in the figures and graphs of the textbooks. Therefore, in the third year the authors would improve the textbooks by colouring some figures or pictures, graphs, and illustrations. Likewise, the instruments need to be improved due to the great difference in the results of the evaluation between those given by experts, teachers, and students. The instruments of evaluation

given to the students contained too many questions and almost all aspects were imposed by the same questions although some aspects were not relevant to a number of certain questions. For example, the aspect of attitude building through leadership stories and proverbs was not relevant to the question on enhancement of creativity. Therefore, the questionnaires given to the students must be revised. The principles that must be deployed in the questionnaires for students should be proportionate, representative, and communicable in terms of design and procedure.

Textbooks on mathematics for Senior High Schools that were written in accordance with the level of students' thinking through daily activities, and technological and socio-cultural development locally could really make students understand the texts easily since the students may relate mathematical concepts to the students' daily experiences (Ausubel, 1963; Schwartz & Curcio, 1995). Included in this way, the writing of this textbook also considered the role of the left brain and the right brain by interconnecting mathematics with other fields, training the students to think creatively, and helping students to understand concepts through colourful figures or pictures (see, Springer & George, 1998; DePoster & Hernacki, 1999; Rubenzer, 1982). In terms of local social-culture, the authors had a difficulty to write such textbooks on mathematics for every province of Indonesia. Four chosen cities were classified into two, two-city groups, each of which represented an east region of Indonesia and a west region of Indonesia. Moreover, each of the two cities of each region represent two different levels of cities, the one represents a developed city and the other represents a developing city. All the four cities had diverse cultures. For instance, Jakarta constitutes a metropolitan city with so many heterogeneous residents; Bengkulu is a coastal and mountainous city with a few number of residents; Makassar is a coastal, flat, and crowded city; and Jayapura is a mountainous city. Therefore, the four cities show various characteristics. Such a way of choice is so common and quite appropriate (Gay, 1992). Hence, any local author is able to write textbooks on real life mathematics by using the handbook.

The results of the tryout for small groups in SMU 6 Bengkulu, SMU UNJ, SMU 11 Makassar, and SMU 1 Jayapura indicate that most students of the sample prefer the textbooks on real life mathematics to the conventional ones. The disadvantage of the use of the textbooks is that

some teachers worry not being able to achieve the target of the curriculum. As a result, the use of the textbooks might not solve the problem of completing the exercises at schools, but some of them can be done at home. Besides that, in relation to games or quizes all students do not have to solve all of the same problems in order to prevent them from being bored and to achieve the target of the curriculum.

CONCLUSION AND SUGGESTIONS

Conclusion

The textbooks on real life mathematics were interesting and entertaining for some students taken in the sample. The textbooks should be corrected by considering the inputs from experts, teachers, and students but in accordance to the handbooks so that the textbooks can achieve good results. Hence, at the end of the third year it was estimated that the textbooks should help students in the Senior High Schools to study mathematics cheerfully and enhance their creativity.

Suggestions

From the result of the study, the researchers have come to offer some suggestions. The authors of the textbooks on mathematics should review more literature on applied mathematics and consider to write textbooks on mathematics with respect to technological visions. Then, for teachers in the Senior High Schools, the important points to use these textbooks should be to master problems in the exercises, understand the sections on activities and inquiry. Finally for researchers, this study may be utilized to focus on the development of the same textbooks but for elementary schools and junior high schools in Indonesia.

REFERENCES

Ausubel, P. (1963). *Psychology of Meaningful Verbal Learning*. New York: Grune & Stratton.

De Poster, B., & Hernacki, M. (1999). *Quantum Learning: Made accustomed to study with pleasant and satisfy.* Bandung: Kaifa.

Djoyonegoro, W. (1996). Ministry of Education: Teachers' anxiety on mathematics and science course. *Kompas.* 1996, July, p. 10.

Gatra (1996). *Mathematics mystery everywhere.* 1996, 22 June, p. 102. Jakarta: PT Era Media Information.

Gay, L. R. (1992). *Educational Research; Competencies for analysis and application.* New York: Merrill.

Kanwil (Kantor Wilayah) Depdiknas Bengkulu (2000). *National Examination Report for the Year 2000.* Bengkulu: Depdiknas.

Kompas (1996). *The low mathematics achievement in vocational secondary schools, (SMK).* 1996, June, p. 10. Jakarta: Gramedia Publishers.

Mulyadi, S. (2000). Mental Arithmetic makes students creative. *Kompas.* 2000, 24 February, p. 6. Jakarta: Gramedia Publishers.

Rubenzer, R. L. 1982. *Educating the Other Half: Implications of Left/Right Brain Research.* Mexico: ERIC.

Suyanto (1996). Educating for some materials of mathematics textbooks in elementary school. *Kompas.* Tuesday, 3 September 1996. Jakarta: Gramedia Publishers.

Schwartz,. S1 & Curcio, Ft (1995). *Learning mathematics in meaningful contexts an action based approach in the primary grades. Connecting mathematics across the curriculum.* Reston, VA: NCTM.

Spriger, S. P. & George D. 1998. 5th Ed. *Left brain, right brain: Perspectives from cognitive neuroscience.* New York: Freeman.

Swita, B. (1998). *Identify for problems on teaching mathematics in elementary school in Bengkulu.* Research report UNIB. Unpublished Report.