Integrated mathematics books with ICT for senior high school

T Septia¹,²,* and S Edriati¹

¹Pendidikan Matematika, STKIP PGRI Sumatera Barat, Jl. Gunung Pangilun, Padang 25173, Indonesia
²Pendidikan Matematika, Universitas Negeri Malang, Jl. Cakrawala No.5, Malang, Jawa Timur 65145, Indonesia

*tikaseptia@stkip-pgri-sumbar.ac.id

Abstract. Mathematics learning based on ICT is learning according to the curriculum of 2013 and it required an integrated ICT teaching materials. Based on observations to some high schools, found that there are no schools used the computer as mind tools in mathematics. This study aimed to develop an integrated ICT textbook that can be used by teachers and students to improve the effectiveness of learning mathematics. To facilitate teachers and students in using the computer program, the book comes with a CD tutorial. CD Tutorial consists of a guide to using multiple software and examples of applied learning senior high school mathematics grade X first semesters. Design research method was adopted in this study. The textbook developed with Plomp model and referred to Tessmer formative evaluation. Self-evaluation and validation sheet are used as an instrument. The findings show that the textbook is valid, practice, and effective from the content and construct aspects. Test results of post-test have increased enough significant impact on a pre-test. The effectiveness of using the textbook is seen by a normalized gain calculation, obtained a normalized gain value of 0.68. It means the textbook developed effectively in improving learning outcomes students.

1. Introduction

The curriculum of 2013 mandates a learning process that involves interaction among learners, between learners with educators and learning resources in the certain learning environment. Mathematics learning based on ICT is learning according to the curriculum of 2013. In this case, required an integrated ICT teaching materials. Based on data from Education Office of Padang City (2015), 88.5% senior high school in Padang already has a laboratory adequate to organize learning by making use of a computer. But, there are no schools used the computer as mind tools in mathematics. Starting from the initial stage of procurement of ICT infrastructure, phase implementation in school management and learning, entering the stage and integrating ICT in learning activities, as well as transformation phase where ICT becomes a natural part of everyday life in school. The use of computers in learning activities at senior high school existing in the city of Padang is just at the applying stage where the teacher using ICT in learning. In this case, the very basic problem is the resources owned by the teacher and other learning resources such as textbooks. Regarding the laboratory, the computer is sufficed, but the ability of teachers in designing teaching materials the integrated ICT is still limited. Therefore, this aim of the study developed an integrated mathematics textbook and ICT equipped with CD Tutorial.

ICT integrated textbook is a book designed with integrating the use of multiple computer programs as a tool thinking on mathematics subjects. The textbook developed in the hope that students are more
motivated to learn because students usually only read the book when going to the exam [1-4]. This textbook comes with a Tutorial CD to help the students learn independently. This study uses ICT as mind tools (tool aids) in the process learning mathematics. Some programs used are under windows programs such as MS Excel, and open source programs such as Wingeom, Winplot, Geogebra. This program is considered necessary because various math applications developed in this software include calculus, differential equations, linear algebra, and graphs. This study hope, the textbook can make the students interest in learning mathematics integrated ICT.

2. Method
The development procedures in this study use a model of design research [5] which consists of 3 phases of preliminary research, prototyping phase, and assessment phase. In the Preliminary research phase, conducted problem and need analysis and literature study. The prototyping phase is making a prototype. Assessment phase is the stage of assessing whether the user can use a textbook (practicality) and wish to apply them and to assess the effectiveness of textbooks. Evaluation methods used in this study is a formative evaluation that took place in all the phases and the development cycle. The formative evaluation has several layers [6], as illustrated in Figure 1.

![Flowchart of the evaluation process](image)

Figure 1. Flowchart of the evaluation process.

Figure 1 illustrates some of the formative evaluation methods commonly used. In this study, the formative evaluation used is as follow: 1) Expert review. At this stage, the expert group (an expert in the field of study, expert instructional design) provides an assessment and advice on the products developed; 2) Self-evaluation is conducted to use a check lists the essential characteristics or design specifications; 3) Evaluation of one-to-one (done by users who are representative of teachers or students); 4) Small group or micro-evaluation: involving small groups of students by using the product in a normal situation. At this stage, the evaluator observed and interviewed the respondents. Field test was also carried out to see the effectiveness interactive textbook developed and to get information to further improvements to textbook developed. The effectiveness of data collected in pretest scores and post-test of students.

3. Result
Data of preliminary phase results obtained through interviews with teachers and students, syllabus document collection and learning implementation plan and textbooks Mathematics SMA / MA / SMK Grade X. Data obtained from the initial investigation results presented the following. 1) Interviews with the teachers and students. In the preliminary phase, showed that teachers' perceptions rather than
instructors from high school groups who had used the 2013 curriculum who were less interested in the use of ICT in learning. Different responses are obtained from teachers and instructors of the 2013 curriculum who feel difficult with the hours given in applying scientific models and textbooks so that it is necessary to have methods and teaching materials that can solve the problem. Similarly, the responses obtained from teachers from school groups who have not implemented the 2013 curriculum consider that there should be innovations in learning that appeal to students so that learning objectives can be achieved. The responses obtained from the sample students are interested in the use of ICT in mathematics learning. Student expectations in the application of ICT are not only limited to the use of PowerPoint as a media presentation by the teacher but can get an interesting learning experience and follow the development of science and technology. Teachers and students from sample schools have never obtained experience in using the mathematical software in mathematics learning. Implementation of ICT has ever done only limited to the use of PowerPoint as a media presentation. The use of this media is considered not much help, otherwise even complicate the students in understanding the concept and the process of calculation. 2) Analyze the syllabus. The syllabus analyzed is the mathematical syllabus of the 2013 curriculum. The material structure that has been compiled based on the syllabus of the 2013 curriculum has been revised in the initial design process due to the revision of the curriculum syllabus 2013 in the middle of 2016. Based on the re-analysis of the mathematical syllabus, the developed textbook is designed into two books that is compulsory books that can be used in high school, MA, SMK, and book specialization for high school and MA.

Developed prototype textbooks based on structures that have been designed. The structure of the textbook can be seen in Figure 2.

![Figure 2. Structure of text book.](image)

The prototype of integrated ICT mathematics textbooks makes based structures that have been designed. Prototyping phase was done following the formative evaluation stage developed by Tessmer. Development is done by designing contextual problems and software appropriate to solve the problem presented. Software used is Microsoft excel for Exponent and Logarithm, Geogebra for Linear and Nonlinear Equations, Linear and Nonlinear Equations Systems, and Microsoft Mathematics for Matrices. The textbook starts with the Exponent and Logarithm material. The example of the textbook can be seen in Figure 3.
The evaluation of the preliminary phase the initial development evaluation of aspects of the presentation of the material is presented as follows in Table 1 and 2. An expert review was conducted to evaluate the revised textbook according to the results of self-evaluation. The review is still in content and layout of the material.

**Table 1. Content and construct validity of the textbook.**

| Aspects         | Validity Aspects | Content | Criteria | Construct | Criteria |
|-----------------|------------------|---------|----------|-----------|----------|
| Layout content  |                  | 2.83    | Quite valid | 2.84     | Quite valid |
| Content         |                  | 2.85    | Quite valid | 2.87     | Quite valid |

**Table 2. General assessment of the textbook.**

| Experts          | 1 | 2 | 3 |
|------------------|---|---|---|
| General assessments of textbook | B | B | B |

Expert validation results show that textbooks developed already contains instructional instructions, competencies to be achieved, exercise, and evaluation in the form of repeat exercises. A textbook
includes among others learning instructions, competencies to be achieved, supporting information, exercises, work instructions can be worksheets and evaluations [3]. Therefore, the presentation of developed textbook material is valid regarding content (relevance). The layout of textbook material also facilitates students to understand independently. Thus, it can be concluded that developed textbooks have been systematically arranged to create an atmosphere that allows students to learn well. Content validity and construct of textbooks regarding content feasibility are categorized quite valid. The validation results show that the material contained in the book teaching is by the scientific principles of the material. Teaching material also has the expected competencies. The textbook that has the content feasibility is if there is conformity of the material with the main competence and competence supporters, material accuracy, and learning support materials [3]. The quality of the textbook depends on its usefulness for learning purposes college student. The more needs that can be served, the better the book teach. For example, providing opportunities for students to study according to its speed; to do deepening; to make a revision and reflection, or to record important things for other purposes. Quality textbooks thus not only lie in the design of the book itself, but also on its usefulness. Good textbooks are not just a collection of ideas, but programmed and systemic designs to work useful, concise yet meaningful [1]. The result of the textbook validation is seen from the content and construct validity of two aspects assessed, obtained by category is quite valid. That is, in content, that material presented in the textbook is by the material that must be studied students to gain learning achievement mathematics subjects. By construct, the material presented in the textbook can lead the students in achieving the expected competencies.

The small evaluation group involving nine students representing the population target. The practicality of data collected through the survey. The analysis score for the survey shows that the textbook has practically used by students. Field test was also carried out to see the effectiveness interactive textbook developed and to get information to further improvements to textbook developed. The effectiveness of data collected in pretest scores and post-test of students.

![Figure 4. Graph pretest dan posttest score.](image)

Seen from the average test scores, been an increase in value sufficiently significant. Thus, can be concluded that the textbook developed effectively in improving learning outcomes students. Test results of posttest have increased enough significant impact on a pretest. The effectiveness of using the textbook is seen by a normalized gain calculation. The results of normalized gain \((g)\) can be seen in Table 3.

| Class     | Pretest | Posttest | Gain  | \((g)\) | Criteria |
|-----------|---------|----------|-------|--------|----------|
| Eksperimen 1 | 42.85   | 83.68    | 40.82 | 0.68   | Medium   |
Based on data from pretest and posttest value of students, obtained a normalized gain value of 0.68. The value is interpreted as the value criterion (g), obtained the effectiveness of textbook classified, in other words, the textbook has been effective in improving student learning outcomes. It concluded that model of technology integration is required for effective learning process [7]. Moreover, ICT helped students in acquiring a more in depth understanding of subject material and improve student’s achievement [8-10].

4. Conclusion
The developed textbook is valid in content and constructs aspect, practice, and effective. Develop the textbook requires mathematics education experts and ICT experts in the field of mathematics education. ICT usage in the classroom has been shown to have a positive effect on students’ motivation and interest, which often results in increased attention and improved behavior, although it cannot improve learning outcomes automatically [11-13].

Acknowledgments
Thanks to DP2M Dikti which have been funding the grant, thanks to UP3M STKIP PGRI Sumatera Barat and FKIP Universitas Sanata Dharma which have been providing an opportunity to do this research.

References
[1] Sappington J, Kinsey K and Munsayac K 2002 Two studies of reading compliance among college Gurung and Landrum
[2] Burchfield C M and Sappington J 2000 Compliance with required reading assignments Teaching of Psychology 27 58-60
[3] Clump M A, Bauer H and Bradley C 2004 The extent to which psychology students read Textbooks: A multiple class analysis of reading across the psychology curriculum Journal of Instructional Psychology 31 227-232
[4] Sikorski J F, Rich K, Saville B K, Buskist W, Drogan O and Davis S F 2002 Student use of introductory texts: Comparative survey findings from two universities Teaching of Psychology 29(4), 312-313
[5] Plomp T 2013 “Educational Design Research an Introduction” in Tjeerd Plomp dan Nienke Nieveen (Eds.), Educational Design Research Part A: An Introduction (hlm. 9-35). Enschede: slo.
[6] Tessmer M 1993 Planning and Conducting Formative Evaluations (ebook) (Routledge: Taylor and Francis group)
[7] Altun S A, Kalayci E and Ümmühan A 2011 Integrating ICT at the faculty level: A case study Turkish Online Journal of Educational Technology 10(4), 230–240
[8] Cox M J and Marshall G 2007 Effects of ICT: do we know what we should know? Education and Information Technologies 12, 59–70
[9] Kulik C L C and Kulik J A 1991 Effectiveness of computer-based instruction: an updated analysis Computers in Human Behavior 7 75–94
[10] Cox M, Abbott C, Webb M, Blakeley B, Beauchamp T and Rhodes V 2003 ICT and attainment: A review of the research literature. ICT in Schools Research and Evaluation Series No.17. Coventry/London: Becta/DfES
[11] Smith H J, Higgins S, Wall K and Miller J 2005 Interactive whiteboards: Boon or bandwagon? A critical review of the literature J. Comput. Assist. Learn. 21 91–101
[12] Watson D M 2001 Pedagogy before Technology: Re-thinking the Relationship between ICT and Teaching Educ. Inf. Technol. 6 251–66
[13] Septia T, Rifai H and Cesaria A 2017 Interactive basic mathematics web using Wordpress J. Phys. Conf. Ser. 943