Development of adaptive contextual teaching model of integrated science to improve digital age literacy on grade VIII students

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Abstract. Literacy skills and integrated teaching are required in science education. However, both integrated teaching and literacy skills can’t be implemented well. Solution of this problem is to develop adaptive contextual teaching model. Type of this research was research and development with ADDIE model. In limited field testing was used before and after design for one group sample. Research instruments consist of validity sheet of teaching model book, practicality assessment sheet of the implementation of teaching model and performance assessment sheet of students. Techniques of data analysis include descriptive statistics and paired comparison test. Results of this research indicate that: 1). contextual teaching model of integrated science is very valid with average value of 89.2, 2). implementation of adaptive contextual teaching model is practice according to science teachers and students respectively 85.78 and 92.50, and 3). implementation of adaptive contextual teaching model is effective to improve digital age literacy of students at 95% confidence level. Thus, this research implies that adaptive contextual teaching model of integrated science is able to promote digital age literacy of grade VIII students.

1. Introduction

In countering the education in the 21st century, the ministry of education and culture in Indonesia has required science subjects in junior high school was done with the integrated science of concepts [1]. In one basic competence has been integrating the concepts of science from the field of biology, physics, chemistry and earth and space science [2]. Integrated science is a combination of biology, chemistry and physics [3]. In another meaning, integrated science integrates the perspectives of sub disciplines from biology, chemistry, physics and earth sciences [4]. Integrated science teaching helps students to think holistically, to understand nature deeper, to apply science more practice, to develop practical abilities and skills, and to influence knowledge, motivation and interaction [5]. Thus, the application of integrated science provides benefits both in the teaching process and teaching outcomes of students.

However, real conditions in implementing of integrated science teaching and literacy skills were found some problems. The first real condition was that science teachers still implement separately science subject on the field of chemistry, physics and biology [6,7]. The second real condition was science teachers have some difficulty in implementing the integrated science teaching in school [8]. The third condition was that the learning material of science in integrated science textbooks also still
separated into the field of biology, physics and chemistry [1, 9]. The last real condition was score and ranking of scientific literacy of students in Indonesia was still low if comparing with other countries. These real conditions imply that the implementation of integrated science teaching and integration of literacy skills in teaching have some problems schools [10, 11].

There were several studies which related to integrated science teaching and literacy have been done by researchers in the field of education. The application of integrated science teaching can improve literacy skills of students [12, 13]. Other researches relate to the application of teaching models such as problem-based learning model and inquiry learning model in integrated science [6, 14, 15]. On the other hand, there were researches which related to the application of contextual teaching to improve thinking and literacy skills of students [10, 16, 17]. The solutions which offered of these researches were still limited to teaching and scope of literacy skills. These limitations of the solutions offered and the results achieved in previous studies have become a good opportunity to solve problems in integrated science teaching and literacy skills of students. Therefore, an alternative solution of the problem in implementing the integrated science teaching and literacy skills was adaptive contextual teaching model (ACTM) by integrating the digital age literacy.

Selection of the teaching model as a solution is a teaching model can be viewed as a systematic and complete teaching guide for teachers to be applied in their teaching. A teaching model can be defined as a pattern or a plan that can be utilized to shape curriculum or course, to select instructional materials and to guide teacher actions [18, 19]. Another definition of the teaching model is a plan that can be used to shape the curriculum, to design teaching materials and to guide instruction [20, 21]. A teaching model consist of guidelines for designing educational activities and environments [22, 23]. Thus, the functions of teaching model are to shape the curriculum, to design the teaching materials, to guide the teaching, and to create the teaching situations.

The selection of digital age literacy on this solution based on this literacy became a relevant issue in the 21st century skills. Researchers haven’t found the results of research which related to the digital age literacy yet. This literacy is considered appropriate because students follow the teaching process in the digital era. They need to have a good digital age literacy to construct the knowledge and apply it in daily life. Digital age is a term used in the emergence of digital, internet network, especially computer information technology. Digital age literacy is the ability in a particular field that is required to find, access, use, and evaluate various information using digital technology and internet. Digital age literacy skills consist of functional literacy, scientific literacy, economic literacy, technological literacy, visual literacy, information literacy and global awareness literacy [24, 25]. Therefore, the effort to create and to develop the digital age literacy is considered crucial in science teaching process.

The development of adaptive contextual teaching model of integrated science needs to be conducted to solve this research problem. In this case, this teaching model was important to be implemented to realize the integrated science teaching, to create the context of science teaching materials, and to develop digital age literacy of students. For this reason, researchers were interested to conduct this research. The objectives of this research were to: 1). determine the validity of adaptive contextual teaching model according to rational thinking from experts to support literacy skills in 21st century and 2). Determine the practicality and effectiveness of the implementation of adaptive contextual teaching model in science teaching on grade VIII students in junior high school.

2. Research Method
Type of research was research and development or R&D. R & D is a research method which used to produce a particular product, and test the effectiveness of the product. The product of this research was an adaptive contextual teaching model. The effectiveness test was conducted on a limited field testing. Development model which used in this research was the ADDIE model. ADDIE is an abbreviation of analyze, design, develop, implement, and evaluate.

The analysis phase relates to a preliminary research which conducted to find the opportunities and problems of science teaching in schools. Activities in the analysis phase include analyzing integrated science in the 2013 curriculum, analyzing the implementation of integrated science teaching,
analyzing integrated science books, analyzing supporting factors to implement the ACTM, and analyzing literacy skills of students. The results of the analysis were descriptions of the science curriculum, integrated science textbooks, the implementation of science teaching and literacy skills of students [26]. Hence, the results of this preliminary research were used as a reference in developing the teaching model.

The design phase refers to the planning activities to design the teaching model and the supporting system of the teaching model. Activities in the design phase are to design the integration of the science base on curriculum, to formulate indicators and objectives of science teaching, to design ACLM, to design supporting system of ACTM. In designing ACTM was used concepts for describing a teaching model include syntax, social system, principles of reaction and supporting system. In addition, in designing the ACTM also considered the philosophy foundation and teaching theory which used to develop a teaching model.

The development phase deals with activities to develop teaching model, supporting system and testing of teaching model. Activities in development phase were to develop ACLM book of integrated science; to develop supporting system of ACLM such as syllabus and lesson plan of science, integrated science textbook, and integrated science student worksheet and assessment. The result of the activities was called as prototype 1 of ACTM. Activities in the development phase also tested the validity of ACTM and its supporting system and revised the ACTM and its supporting system. The result of the activities was called as prototype 2 of ACTM. Other activities in the development phase were to do the limited field testing and to revise ACTM and its supporting system. The result of these activities was known as prototype 3 of ACTM. Thus, the product of the development phase was the ACTM and its support systems which have been tested in its practicality and effectiveness in limited field testing.

The implementation phase refers with activities to implement the ACTM on a wider scale. Field testing was conducted on three junior high schools in Padang city. Activities in this phase include preparing science teachers, preparing students on grade VIII, conducting field testing on a wider scale, revising teaching model book and its supporting systems. Hence, the result at this phase was prototype 4 of the ACTM.

The evaluation phase was concerned with efforts to evaluate the products and processes that have been implemented. Activities at this phase include assessing the results achieved, problems and constraints in implementation, and follow-up of activities. Thus, the evaluation results were made as the basis for making decisions about the follow-up of the implementation of this teaching model.

The instruments to collect data consists of three parts namely the validity sheet, the practicality sheet, and the performance assessment sheet. The validity sheet was used to assess the validity of the ACTM and its support systems. Indicators of validity instruments include concepts for describing a teaching model, presentation, language and graphic. The practicality sheet was used to assess the practicality of implementation ACTM in integrated science teaching. Indicators of practicality instrument include useful, easy to use and appealing. The performance assessment sheet was used to assess the digital age literacy skills of students in the ACTM. Indicators of performance assessment include writing, describing the information, counting, scientific concepts, scientific processes, scientific contexts, visual interpretation and visual creation. Therefore, the instruments to collect data were arranged base on these indicators.

Data of research result were analyzed by descriptive statistics analysis paired comparison test. Descriptive statistics analysis was used to give information about a data group of validity of ACTM book, practicality of implementation ACTM, and effectiveness of ACTM. The effectiveness of implementation of teaching model was digital age literacy skills of students. Parameters of statistical analysis include minimum value, maximum value, range, mean value, median, mode, and standard deviation. Paired comparison test was used to determine the difference in mean value of skills competence of students before and after treatment. Skills competency can be seen in digital age literacy of students include functional literacy, scientific literacy, and visual literacy of students in teaching model.
3. Result and Discussion

The first result of this research is validity of ACTM book. Assessment of validity of ACTM book was done by 5 experts consisting of science education, language, physics, and biology. The component of validity assessment of ACTM book of integrated science consists of concepts for describing model, language, presentation, and graph. Data from validity assessment of expert were processed with descriptive statistics including mean value, minimum value, maximum value and graph method. Result of validity assessment of ACTM book can be seen in Figure 1.

Value of concepts for describing teaching model varies from 80.0 to 93.3 with range 13.3. Mean value of teaching model concepts is 87.6. Value of language component varies from 85.0 to 100.0 with a range of 15.0. The average value of the language component is 89.2. Value of presentation component in teaching model book of varies from 85.0 to 95.0 with a range of 10.0. The mean value of presentation component in the teaching model book is 90.0. On the other hand, value of graph component of the teaching model book varies from 80.0 to 100.0 with a range of 12.0. The average value of the teaching model book components is 90.0. In this case, components to describe the ACTM consist of syntax, social system, principle of reaction, support system, effects of model and teaching theory to construct of this ACTM. The mean value of concepts for describing the teaching model, language component, presentation component, and graphic component is 89.2. This means that this average value can be classified into very valid category. Therefore, this result indicates that ACTM book is very valid according rational thinking from experts.

Second result of research is the practicality of implementing the ACTM according to science teachers and grade VIII students. Three science teachers have tried to implement the ACTM in the real condition. After implementing this teaching model they assess the practicality of implementation the teaching model. The instrument which used to obtain data was practicality assessment sheet. The assessment component consists of three indicators namely usable, easy to use and appealing. The descriptive statistical parameter value of the three indicators of practicality of implementation the teaching model is shown in Figure 2.
From the data in Figure 2, it can be explained that the value of usable indicator varies from 75.0 to 100.0 with a range of 25.0. The average value of the usable indicator is 81.9. Value of easy to use varies from 75.0 to 91.7 with a range of 16.7. The mean value of easy to use indicator is 82.1. Meanwhile the value of appealing indicator of implementation of teaching model varies from 91.7 to 100.0 with a range of 8.3. The mean value of the appealing of implementing the teaching model is 93.1. The mean value of usable, easy for use and appealing indicators can be grouped into very practical category. The mean value of three assessment indicators of implementation the ACTM is 85.7. This average value can be entered into a very practice category according to science teachers. This means that science teachers consider that ACTM is useful for achieving teaching objectives, making science teaching easier, implementing science teaching better, accelerating the presentation of learning materials, improving the productivity of teaching activities, enabling students to learn in real-world context, and controlling the time of teaching. In addition, science teachers also consider that the use of ACTM is practice on aspects of easy to use and appealing. Thus, the result of this research indicates that science teachers consider the implementation of ACTM was useful, easy to use and appealing in integrated science teaching.

Third result of this research is the effectiveness of implementation of ACTM of integrated science to improve digital age literacy. There are three components of digital age literacy which assessed in implementing the ACTM. These components are functional literacy, scientific literacy, and visual literacy. Functional literacy includes writing, describing information and counting or drawing. The scientific literacy consists of three parts namely scientific concepts, the scientific processes, and scientific contexts literacy. In other sides of visual literacy includes to interpret visual and to use visual. The value of digital age literacy of students before and after implementing this ACTM is displayed in Figure 3.
Before implementing the ACTM in science teaching, 50% of the students obtained the value of functional literacy between 50.0 to 66.7, the value scientific literacy between 50.0 to 68.8 and the value of visual literacy between 50.0 and 75.0. After implementing the ACTM in science teaching, 50% of students obtained the value of functional literacy between 75.0 to 100, the value of scientific literacy between 63.2 to 82.6 and the value of visual literacy between 68.8 to 87.5. The average value of functional literacy increased from 54.8 to 76.8, the average value of scientific literacy increased from 53.0 to 66.4 and the average value of visual literacy also increased from 50.0 to 68.8. Therefore, the average value of functional literacy, scientific literacy and visual literacy of 28 students after following the ACTM in science teaching was higher than before following it.

Data groups of functional literacy, scientific literacy and visual literacy were analyzed with appropriate statistics. Normality test was used to determine the distribution form of the data groups of literacy of students. Homogeneity test was used determine the similarity of the variance of the two data groups. Result of normality test and homogeneity test were made as a consideration to use the paired comparison test. Result of normality test, homogeneity test and Wilcoxon paired comparison test were shown in Table 1.

**Table 1. Normality test, F test, and Wilcoxon paired comparison test**

| No | Statistics Parameter | Functional Literacy | Scientific Literacy | Visual Literacy |
|----|----------------------|---------------------|---------------------|----------------|
| 1  | Normality test before treatment | | | |
|    | AD                   | 3.36                | 1.109               | 3.787          |
|    | P-Value              | 0.005               | 0.006               | 0.005          |
| 2  | Normality test after treatment | | | |
|    | AD                   | 1.053               | 1.156               | 0.836          |
|    | P-Value              | 0.008               | 0.005               | 0.027          |
| 3  | F Test               | | | |
|    | Test statistic       | 0.32                | 0.93                | 0.62           |
|    | P-value              | 0.004               | 0.851               | 0.226          |
| 4  | Z value of Wilcoxon Paired comparison test | | | |
|    | -4.650               | -4.623              | -4.048              |
| 5  | Significant value    | | | |
|    | 0.05                 | | | |

**Figure 3. Value of Digital Age Literacy Component of Students**

Before implementing the ACTM in science teaching, 50% of the students obtained the value of functional literacy between 50.0 to 66.7, the value scientific literacy between 50.0 to 68.8 and the value of visual literacy between 50.0 and 75.0. After implementing the ACTM in science teaching, 50% of students obtained the value of functional literacy between 75.0 to 100, the value of scientific literacy between 63.2 to 82.6 and the value of visual literacy between 68.8 to 87.5. The average value of functional literacy increased from 54.8 to 76.8, the average value of scientific literacy increased from 53.0 to 66.4 and the average value of visual literacy also increased from 50.0 to 68.8. Therefore, the average value of functional literacy, scientific literacy and visual literacy of 28 students after following the ACTM in science teaching was higher than before following it.

Data groups of functional literacy, scientific literacy and visual literacy were analyzed with appropriate statistics. Normality test was used to determine the distribution form of the data groups of literacy of students. Homogeneity test was used determine the similarity of the variance of the two data groups. Result of normality test and homogeneity test were made as a consideration to use the paired comparison test. Result of normality test, homogeneity test and Wilcoxon paired comparison test were shown in Table 1.
The data group of student’s literacy value before and after implementing the ACTM isn’t normally distributed. Besides that, from the F test, the two groups of student’s literacy value data with 27 freedom degree doesn’t have same variance. For this reason the Wilcoxon test for paired comparison is used to data analysis. From the test the difference of two average paired found the value \( Z = -4.7 \). At significant level \( \alpha = 0.05 \) is found the value a half of this significant value is 0.025 then the area of the curve \( F(z) \) is 0.475. \( Z \) value of table for \( \alpha = 0.05 \) is 1.9. This value is located in the rejection area of null hypothesis. This means that the working hypothesis is accepted on significant confidence of 95%. This means that there is a significant difference of functional literacy value of students between after and before implementing ACTM. Therefore, the implementation of the ACTM is effective to improve functional literacy skill of grade VIII students at 95% confidence level.

The average value of scientific literacy and variance respectively 66.4 and 80.1. From normality test, the distribution of group data of scientific literacy of students between before and after implementing the teaching model isn’t normally distributed. While, from the F test it is known that the two groups of paired data come from the same variance. Base on two conditions then it is used the Wilcoxon paired comparison test. From this paired comparison test is obtained the value \( Z = -4.6 \) at significant level \( \alpha = 0.05 \). On a half \( \alpha \) value of 0.05 is found area of \( F(z) \) curve is 0.475. Value of \( Z \) in table for this condition is 1.9. This means that value of calculated \( Z \) is outside the acceptance area of null hypothesis. From this value of calculated \( Z \) it can be stated that there is a significant difference in scientific literacy value of students between after and before implementing the ACTM. Therefore, it can be concluded that the implementation of ACTM is effective to improve scientific literacy of grade VIII students at 95% confidence level.

The average value of visual literacy of students after implementing this ACTM is 67.6. It means the average value of visual literacy of students after implementing the ACTM is higher than the average value before implementing it. The data group of visual literacy value of students before and after implementing the ACTM isn’t normally distributed data. On the other hand the data group before and after implementing the ACTM have same variance. For this reason, it is used Wilcoxon paired comparison test. The average value for negative rank and positive rank is respectively 3.5 and 11.9. The value of \( Z \) for the difference of two paired average is found \( Z = -4.0 \). This value of calculated \( Z \) is outside of acceptance area of null hypothesis. From the value of calculated \( Z \) it can be stated that there is significant difference in visual literacy value of students between after and before implementing the ACTM. From this condition it can be concluded that the implementation of the ACTM is effective to improve visual literacy of grade VIII students at 95% confidence level.

The validity of ACTM book can be classified into very valid category. This is happened because the validity assessment instrument of experts has been built based on indicators of a teaching model. The implementation of ACTM is considered very practice by science teachers. This indicates that the implementation of the ACTM is useful, easy to use, and appealing according science teachers. An intervention is said to be practical if users consider the intervention to be usable and that it is easy for them to use [27]. Practicality refers to the extent that users consider the intervention as appealing and usable in normal conditions [28]. Besides that, the implementation of the ACTM is effective to improve digital literacy skills of students including functional literacy, scientific literacy, and visual literacy. This condition indicates that the result obtained in accordance with the goals set. Effectiveness means that the experiences and outcomes from the users of the prototype are consistent with the intended aims [41]. Thus, science teachers can implement the ACTM of integrated science to improve the digital literacy of students.

4. Conclusions
Three results of this research indicate the importance role of developing teaching model to improve the digital age literacy of students in integrated science. First, validity value of ACTM book is very valid with average value is 85.52. Second, average value of implementation the ACTM of integrated science according science teachers and students are respectively 85.78 and 92.60. This average value can be classified into very practice category. Third, implementation the ACTM is effective to improve
the digital age literacy of students include functional literacy, scientific literacy, and visual literacy skill of students at 95% significant confidence. The implications of the results of this research can gain the results of research which related to the development of teaching models, integrated science teaching and digital age literacy. Both integrated science teaching and digital age literacy have become a relevant issue which need to be further investigated. For this reason, research to develop a teaching model which relevant to the characteristics of science and digital age literacy is a part of research functions to improve the quality of science teaching in schools. In addition, the digital age literacy is a part of the 21st century skills which need to create and to develop on students in future science education.

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