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Design and Feasibility of EXE Learning Media on the Topic of Chemical Bonding

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Abstract

The transformation on the industrial era 4.0 has greatly influenced changes in the way students learn who are more dominantly use gadgets both online and offline. This research aims to develop an e-Learning XHTML Editor (EXE) learning media which is feasible to be used in chemistry learning on the topic of Chemical Bonding, and also to test the validity and practicality of the media. The study used a research and development (R & D) design by adapting Hannafin and Peck's model. The steps are limited to the design of EXE learning media. The feasibility of the EXE learning media is tested in terms of validity and practicality. The instrument used are validation questionnaire and students' response questionnaire. The data were obtained and analyzed by using descriptive percentage. The results of the feasibility test conducted by the material experts, media experts, and teachers obtained an average of 89% with very feasible category. Meanwhile, the practicality test was obtained from the results of students' response questionnaire from SMAN 8 Samarinda and SMAN 3 Tenggarong, showing the practicality value is 87% with the category of very practice and easy to operate and useful. It means the EXE learning media is feasible and practice to be used as chemistry learning media on the topic of Chemistry Bonding.

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INTRODUCTION

Changes and transformations that occurred in the industrial era 4.0 are very influential on changes in the way of students' learning. In the modern world, every student has known how to use computer, tablet, and mobile phones, so this requires teachers to develop learning strategies that are able to follow the demands of using information technology (IT)-based learning media. Information technology can help the teachers and students in having up-to-date information and knowledge by various methods as well as in accessing various learning resources repeatedly and more flexibly anywhere and anytime (Behera, 2020; Hamidi et al., 2011). The use of IT in classroom has left behind the traditional teaching methods and encouraged a shift in learning from conventional learning to independent learning, so that the impression of learning will be longer understood and remembered by students.

Learning media are required as a tool to convey learning materials and information to students. By using learning media, the learning process will be more interesting, varied and clarify, because it can present the learning material in various forms: animation, video, figure, and text. Sahronih et al. (2020) stated that there was an effect of learning media interaction on the learning motivation and outcomes of students. It means that the development of learning media is indispensable for effective teaching and learning.

The development of learning media must be adapted to the needs of students and teachers in the digital area. EXE-learning media is one of the interesting IT-based learning media to be developed to assist independent learning both at school and at home. The EXE is an abbreviation of e-learning XHTML editor, which is an 'authoring environment' that is designed to help teachers and lecturers develop, build, and disseminate web-based learning materials without having to mess around with the language of HTML programs and the complexity in packaging and deploying web-based applications. EXE is free to use, small in size, open-source, object-oriented, easy to use, and multi-platform. The goal of EXE is to provide software that is intuitive, interactive, and easy to use.

EXE is WYSIWYG (What You See Is What You Get), meaning that developers can immediately see the final results of the material developed. EXE does not require an internet connection during the development process, so this program can solve the user who has low connection in bandwidth or does not have connectivity. EXE can produce online material formats that can be accepted by various LMS (Learning Management System) platforms. The EXE learning program have been widely used to develop various learning media, including e-module for chemistry material (Silalahi, 2020), web-based teaching materials for mathematics (Prasetyani et al., 2019), multimedia instructional unit in Statistics (Navarro et al., 2019), mathematics learning media (Rokhima et al., 2019), and learning media in implementation of Attention, Confidence, Relevance, Satisfaction learning model (Aini et al., 2017). In this study, we used EXE learning program to develop learning media for chemistry material on the topics of Chemical Bonding.

Chemical bonding is the heart of chemistry studying on the making and breaking of bonds. Understanding of chemical bonding involves a number of concepts including molecule, atom, proton, neutron, electron, ion, cation, anion, attraction of opposite charges and repulsion of like charges. Therefore, this topic is one of the most fundamental concepts in chemistry that is associated with another chemistry concepts, such as chemical reactions and structure-property relationship (Tsaparlis et al., 2018). It means that errors in understanding this concept can interfere in learning the other interrelated concepts. Kumpha et al. (2014) stated that the chemical bonding concepts is the most difficult concept to be understood by students. This is in parallel with Fadillah & Salirawati (2018) reported that more than 50% of learner experienced misconceptions in chemical bonding.

Misconception in chemistry is due to the difficulty of students in describing chemical compound in three levels of chemistry representation: macroscopic, sub-microscopic, and symbolic (Dawati et al., 2019; Meltafina et al., 2019). In addition, many of these misconceptions were caused by the presentation of a rather limited and incorrect picture in the textbook (Tsaparlis et al., 2018). Therefore, EXE-learning media is considered as a learning media that can present the three levels of chemistry representations and can overcome the limitation of textbook in presenting the picture of the issues related to chemical bonding. The EXE learning media provides a variety of i-Devices allowing to insert a variety of animations, simulations, quizzes, practice questions with feedback and so on (Silalahi, 2020). In EXE Learning media, teachers can insert animated videos to help in explaining the abstract concepts of chemical bonding and to assist in reducing the misconceptions.

The EXE-Learning media can be applied in the learning process to increase the activity and interaction of students during the learning process (Rozalinda et al., 2018; Siboro et al., 2017). The use of online or offline animation media can improve learning outcomes and learning motivation of students, as well as the interaction between students in the classroom (Rosen, 2009). This study aimed to develop the EXE-Learning media for chemistry learning on the topic of Chemical Bonding and test the feasibility and practicality of the EXE learning media for chemistry learning. Through the use of the developed EXE Learning media, it is expected that students can learn and do repetition at home independently, and finally it can improve students' chemistry learning outcomes on the topic of Chemical Bonding.

METHODS

This study uses research and development (R&D) methods adapting the model developed by Hannafin and Peck's (1988). The stages in this model included: (1) needs analysis; (2) design; and (3) development and implementation. In this model, evaluations and revisions are carried out at each stage. This research only reached the development step because it was only used for feasibility trials.

In need analysis stage, data were collected by giving questionnaires for teachers to obtain information about the needs to develop a new learning media based on EXE program. At this stage, we also identified content standards and learning objectives as well as an analysis of the scope of learning material that will be developed in EXE-learning media. The questionnaire data were analyzed in a descriptive qualitative manner. After all the needs for the development of EXE Learning media are fulfilled, then an evaluation is carried out through discussions with experts

In design stage, EXE learning media was designed by doing the following activities: (1) software setup; (2) designing the initial display media; (3) creating a main menu display materials, exercises and other supporters of the menu; (4) preparing learning materials, and (5) creating interactive tests along with scores of the assessment. The product design was then re-evaluated by material experts and media experts.

At development stage, the product design was tested by six validators: two material experts, two media experts, and two teachers. Validation test was done using categories from the Likert scale with a score range of 1 to 4, in where score 1 for the vary bad category, score 2 for the bad category, score 3 for the good category and score 4 for the very good category. The validation data of experts is calculated quantitatively by changing the scores into percentages in each aspect measured using the formula, as follows:

$$\text{Percentage (\%)} = \frac{Total\ score\ of\ validators}{Maximum\ score} \times 100\%$$

To determine the validity of each aspect, the calculated results are interpreted following the percentage category according to Riduwan (2015): 0 – 20% is very invalid, $20 < x \leq 40\%$ is invalid, $40 < x \leq 60\%$ is quite valid, $60 < x \leq 80\%$ is valid, and $80 < x \leq 100\%$ is very valid. Comments and suggestions provided by the validator are also used as a basis for improving the developed EXE-Learning media.

The practicality of media was tested at two schools: SMAN 8 Samarinda and SMAN 3 Tenggarong. Data was collected using students' response questionnaires with the indicators of: students' motivation in learning chemistry, curiosity, interest in learning chemistry, ease in learning chemistry, and to add new knowledge and experience. Data on students' response questionnaire measured after the learning process were analyzed using the following formula:

$$\text{Value} = \frac{Obtained\ score}{Maximum\ score} \times 100$$

Based on the calculated value, the practicality criteria of learning media are presented as follows: very good ($80 < x \leq 100$), good ($60 < x \leq 80$), enough ($40 < x \leq 60$), bad ($20 < x \leq 40$), and really bad ($0 \leq x \leq 20$).

RESULTS AND DISCUSSION

Needs Analysis for Development of EXE Learning Media

The needs analysis stage was carried out to obtain an overview of the content and display of EXE learning media according to the learning objectives and desires of users (teachers). Based on the questionnaire results, we obtained information that most teachers need a learning media that can help students in concreting the abstract chemical concept on the topic of Chemical Bonding. The scopes of learning materials related to the topic of Chemical Bonding to be developed in EXE learning media, included: stability of elements, Lewis structures, ionic bonding, covalent bonding, coordination covalent bonding, metallic bonding, polarity of covalent bonding and properties of compounds. After evaluation and review, we obtained the media

specification for developing EXE learning media consisting of all menu in EXE menu panel: *File, Tools, Styles and Help, Outline Setting (Add Page, Delete, and Rename)*, and *iDevice development* (activity and external website). The needs for developing EXE Learning media were aimed to assist students in repeating learning independently anywhere at school or at home. In this study, we developed the EXE learning media that can be applied either using a laptop or android to be easily used for chemistry learning whenever and wherever.

Design of EXE Learning Media

The design of EXE Learning media developed for the topic of Chemical Bonding consisted of several pages presented in the form of a menu format to make it easier for students to choose the material menu they want to learn. This menu display format is also intended to students can use the EXE learning either linearly (sequentially) or nonlinearly (non-sequentially). There are 14 menus available in the developed EXE Learning media. The first menu is the display intro, which contains a mind mapping regarding chemical bonding material. The intro display can be seen in Figure 1.

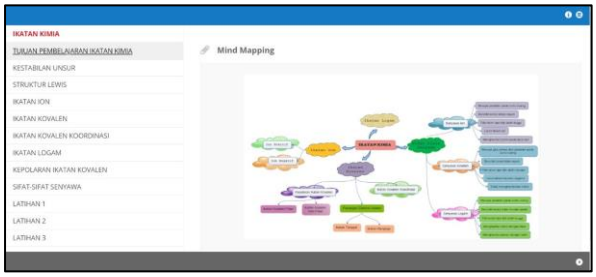

Figure 1. Intro Display

This mind map contains a summary of material or chapters on Chemical Bonding made in the form of a flowchart to help students understand the material or chapter to be studied. Mind map will improve the students' ability to memorize and strengthen the concept understanding (Fatmawati, 2016). Through mind maps, students can see in detail the linkages of information between topics or chapters (Anggaraeni et al., 2018; Yenti et al., 2019). This mind map can also attract eye attention, not boring, and makes it easy to concentrate and remember. Awanda et al. (2020) and Purnama et al. (2015) reported that the use of mind maps can improve students' chemistry learning outcomes in the Chemical Bonding subject.

The second menu of EXE learning media contains the learning objectives of chemical bonding topic derived from the basic competencies that must be mastered by students after learning process. The learning objectives of each lesson topic is important for students, so they can know what competencies that should they possess and master after learning process (Harden, 2002). Menu of learning objectives for the Chemical Bonding subject can be seen in Figure 2.

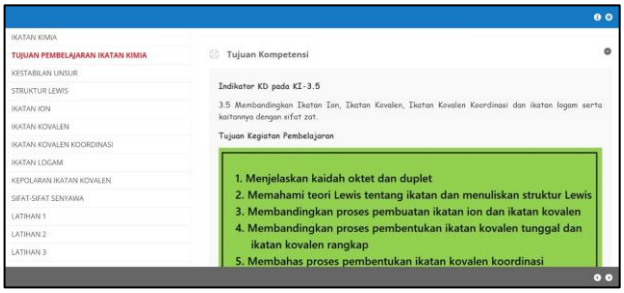

Figure 2. Display of learning objectives menu for Chemical Bonding topic

The third to tenth menu contain sub-material Chemical Bonding, consisting of 8 sub-materials: (1) Stability of elements; (2) Lewis structures; (3) Ionic bonds; (4) Covalent bonds; (5) Coordination covalent bonds; (6) Metal bonds; (7) The polarity of covalent bonds; and (8) The properties of compounds. Presentation of sub-material in the EXE Learning media was carried out in various forms: the form of text/narration, animation, video, and images. The presentation of material in the form of videos, animations and pictures is intended to increase the conceptual understanding in chemistry (Adhi & Linuwih, 2018; Pekdag, 2010), because the use of various modes of representation can connect the three levels of chemical representation: macroscopic, sub-microscopic, and symbolic (Farida et al., 2018). One example of display sub-menu material in text form can be seen in Figure 3.

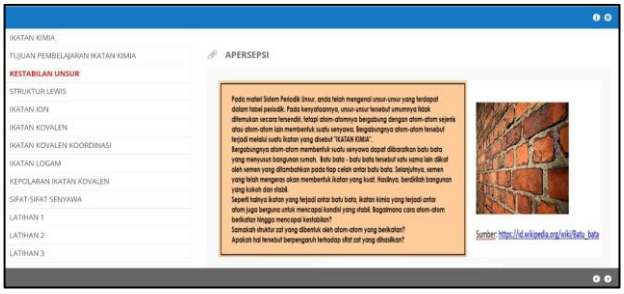

Figure 3. Example display sub material pages are presented in the form of text, tables, and figures.

The eleventh and thirteenth menus are questions exercises that are accompanied by answer keys so that students can evaluate for themselves whether the answers they have given are correct or wrong. Questions have long been used as a teaching tool to assess student's knowledge. The display of the

questions exercise menu page in the types question of multiple choices (exercise 1), fill in the blank (exercise 2), and fill in the blank by dropdown answers (exercise 3) were shown in Figure 4, 5, and 6, respectively. The developed EXE learning media provides three types of questions, because each question formats require different levels of thinking and presenting different kinds of challenges. According to Medawela et al. (2018), fill in the blank type question are perceived more challenging than multiple choice questions because students tend to prefer short cuts and recall type assessments. Javid (2014) also reported that different test formats have any effect on the students' performance in assessing their level of understanding on the concepts learned.

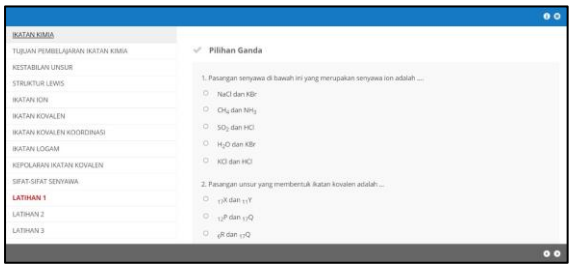

Figure 4. Display of the exercise menu page in form of multiple choices question (Exercise 1)

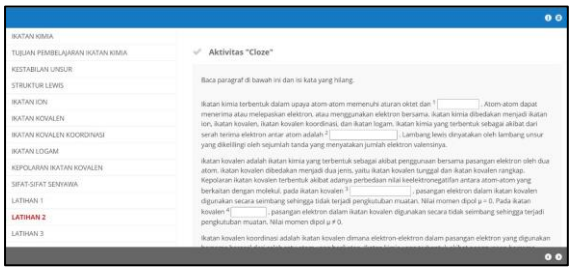

Figure 5. Display of the exercise page menu in form of fill in the blank questions

Figure 6. Display of exercise page manu in form of fill in the blank questions by dropdown answer

The fourteenth menu is a quiz, which contains questions to measure students' understanding of the learning materials they have learned. The type of test format chosen in this EXE learning media is multiple choices, because multiple choices are an effective assessment to measure knowledge domain. Brady (2005) found that multiple choice questions are efficient, objective, easy to grade and can be used to assess performance in relation to the aims of the curriculum in teaching and learning process. The display of the quiz menu page can be seen in Figure 7.

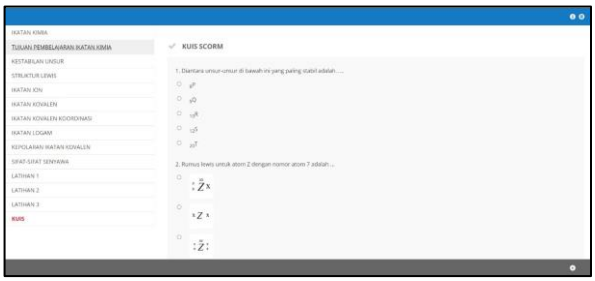

Figure 7. Display of quiz menu page

Validity of EXE Learning Media

The feasibility of EXE Learning media was assessed by experts using questionnaires. The aspect assessed included: (a) content, (b) media presentation, (c) usability, and (d) media display. The aspect of content was only assessed by material experts, and the three other aspects were assessed by all experts and teachers. Content validity aspect relates to conformity of content with basic competency and learning objectives, correctness of concepts, apperception presentation, clarity of learning topic, sequential and coverage of learning materials, suitability of difficulty and abstraction levels of concepts with cognitive development, and content of cognitive aspect. Meanwhile, media presentation, usability, and media display are three aspects in assessment of construct validity. The results of experts and teacher validation are presented in table 1.

Table 1. Results of expert validation

Aspect	Validation percentage			Average
	Material experts	Media experts	Teachers	
Content	94%	-	-	94%
Media presentation	80%	85%	95%	87%
Usability	85%	90%	93%	89%
Media display	85%	85%	88%	86%
Overall validity assessment				89%
Criteria				Very valid

The expert validation assessment referred to Table 1 showed that the validity of EXE learning media from each expert and teachers shows very valid

criteria indicating that the EXE learning media was very feasible for use in chemistry learning. Nevertheless, this EXE Learning media has several shortcomings, namely: there is no sub material about virtual practicum developed in the media, and the amount of video content, animation, and supporting images is still lacking. However, virtual practice content, videos, animations, and images can be added to the media at any time if needed. The EXE Learning developed is expected to increase the effectiveness of learning which increases student chemistry learning outcomes.

Practicality of EXE learning media

Practicality of the EXE learning media was measured through the student's response questionnaire carried out in two high schools: SMAN 8 Samarinda and SMAN 3 Tenggarong. The analysis results of students' responses on the use of EXE learning media showed the average of value is 91.5 (Figure 8). It means that the EXE learning media in chemistry learning is effective to improve students' activity in learning. Bhattacharjee (2015) stated that students' involvement in learning can construct their knowledge based on their new experience and learners will continually update their own mental models to reflect the new information.

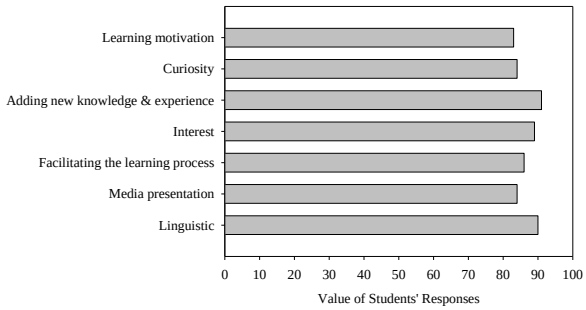

Figure 8. Result of students' responses questionnaire

Based on our data analysis, students give a good response on all of the measured aspects. Good response of students for the aspects of learning motivation, interest, facilitating the learning process and media presentation were due to the presence of mind map, videos, animations and pictures in the EXE learning media. As reported by Liu & Elms (2019) and Ejimonye et al. (2020), animation video can enhance students' learning experience and students' motivation. In addition to arouse the students' interest, Kosterelioglu (2016) also found that the use of video clips in learning can improve memory in learning and provide intelligibility of the topic. This media is also considered capable of shortening time in delivering subject matter and students can be more active in learning.

According to the teachers' responses on the use of EXE learning media in chemistry learning, they felt that the developed learning media was very helpful in implementing and conveying the abstract concept of chemistry learning material. This was in line with stated by Kim et al. (2007) and Abdulrahaman et al. (2020) that the multimedia application can turn abstract concepts into concrete contents and can stimulate students' interest in learning. The teacher also stated that the developed EXE learning media can make students more independent in learning and assist teachers in linking the concepts of material that they have learned previously to the concept of the material being studied at this time. This indicated that the use of EXE learning media which is applied in chemistry learning can attract students to study chemistry and help teachers in achieving learning goals.

The advantage of this EXE Learning media is that this media can be run both online and offline. Unlike other e-learning applications, such as Edmodo, Google Classroom, and Kahoots, which must be done by online. The use of EXE Learning media is also very flexible because it can be used both using a laptop and an android. Nowaday, this become an important reason for developing various android-based learning media (Novaliendry et al., 2020; Sa'diyah et al., 2021), because the use of android have been a daily needs for teachers and students. Adrizal et al. (2020) and Pahlifi & Fatharani (2019) also develop android-based learning media for learning to improve motivation and cognitive learning outcomes of high school students.

CONCLUSION

Based on the results and data analysis, we designed the EXE learning media consisting of 14 menus including: intro, learning objective, sub-topic materials (7 sub-topics), exercise (3 types of question), and quiz. We conclude that the developed EXE learning media on the subject matter of Chemical Bonding in this study is declared very valid by material experts, media experts and practitioners. The average validity value of EXE learning media is 89%, indicating that this learning media is feasible to be implemented in chemistry learning. The practicability value of EXE learning media is 91.5, indicating that the EXE learning media have good responses in terms of presentation, that can foster a student's sense of interest in

chemistry learning, can add new knowledge and experience, increase curiosity, as well as being able to increase student motivation to study chemistry. It means that the EXE learning media is very feasible and practice for use in chemistry learning.

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