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Interactive Media Tutorial Model Based on Concept Hierarchy: Improving Chemistry Learning Outcomes in Salt Hydrolysis Material

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Abstract: The purpose of this study was to produce valid, practical, and effective interactive media in improving students' learning abilities on salt hydrolysis material. The development procedure used in this study is the development model from Borg and Gall and the instructional design step from Dick and Carey which is divided into 4 stages including the needs analysis stage, the product design stage, the validation and evaluation stage, and the final product stage. The media validity test was carried out by expert validators which included chemical material experts, media experts, and instructional design experts. While the practicality test and effectiveness test were carried out in class XI MIA 2 SMA N 1 Karang Baru Aceh Tamiang. The results of the interactive media validation of the tutorial model based on the concept hierarchy on the developed salt hydrolysis material were declared very valid with a percentage gain of 80.42% for material experts, 81.94% for media experts, and 83.61% for learning design experts. As for the percentage score of the practicality of the media, it was 89.57%, which was included in the very practical category. While the effectiveness of the media on students' learning abilities can be seen through the results of the N-gain test where the average N-gain score obtained is 0.5 (moderate category) or 56.34% which is quite effective.

Keywords: interactive media; salt hydrolysis; tutorials; concept hierarchy

1. INTRODUCTION

The reality that occurs in learning chemistry at school is that learning chemistry is considered difficult by students so most students are not successful in achieving the minimum completeness criteria (KKM) [1]. Chemistry learning is quite difficult because there are abstract chemical concepts and chemistry has a special vocabulary which is a new language for students [2]. In addition, chemistry is continuous, that is, the concepts are interconnected with one another. Therefore, chemistry must be studied coherently and continuously so that the concepts received by students can be properly assimilated and accommodated [3]. Besides that, chemical concepts need to be represented in a representation that is easier to understand, including the concepts of salt hydrolysis.

Hydrolysis of salt is a material with concrete and abstract characteristics, so understanding it requires a good ability to combine three chemical representations, namely macroscopic, submicroscopic, and symbolic. The concrete nature of this material lies in the macroscopic representations that are often encountered in everyday life. The abstractness of this material is related to the microscopic representations associated with salt solutions. In addition, the characteristics of salt hydrolysis are also the same as chemicals in general, namely having complexity in it, which means there is a connection with previously studied materials as prerequisites [4]. For example, Bronsted-Lowry acid-base material acts as a prerequisite material for understanding salt hydrolysis material so students who have not mastered Bronsted-Lowry acid-base material well will most likely experience difficulties in understanding salt hydrolysis material. In addition, the concept of hydrolysis must also be understood correctly because it will be used to study the next chemical concept, namely acid-base titration [5].

To understand the concepts of salt hydrolysis, students must understand the concepts of acid-base, acid-base equilibrium, dissociation of salt constituent ions, and the properties of reactants and products related to salt hydrolysis [6]. In addition, the salt hydrolysis material is one of the materials that combine concepts and calculations [7], so students often experience difficulties in solving questions whose completion requires high levels of metacognition and mathematical chemistry strategies.

In connection with the complexity of salt hydrolysis material, problems often occur when students are faced with questions related to the calculation or the use of other formulas, many students have difficulty determining which formula to use, so one step that can be taken to overcome this problem is to represent the concept of salt hydrolysis in a simpler form with the help of media based on concept hierarchies. Concept hierarchies are levels from the most general concepts to the most specific concepts [8] or from simple concepts to complex concepts [9] so that students' constructive stages can be monitored in the correct order [10]. The concept hierarchy applied to learning media can reinforce students to deal with problems with systematic completion steps [11].

Smartphone-based learning media in this study the Android system only requires a memory space which is not too burdensome for students' devices but the use of this application must be downloaded first [12]. In addition, the use of Android-based learning media allows students to access learning materials without being bound by time and place [13]. Several literature studies state that the use of Android-based learning media (mobile learning) has many advantages that can replace computer-based learning media [14][15].

1.1 The Nature of Chemistry Learning Outcomes and Outcomes

According to Hamalik [16] Learning is a modification or strengthening of behavior through experience. One sign that someone has learned something is a change in behavior in him. Changes in behavior involve changes in knowledge (cognitive) and skills (psychomotor) as well as those involving values and attitudes (affective).

Meaningful learning is a process of linking new information to relevant concepts contained in one's cognitive structure, whereas rote learning will occur if one's cognitive structure does not contain relevant concepts to link newly learned concepts. In a series of lessons, students should be introduced first to the most general or inclusive concepts, then gradually become more specific concepts, in other words from general to specific [17].

According to Sudjana [18] learning outcomes are the abilities possessed by students after they receive their learning experience. Students who do the learning will get the results of the learning process. According to Suardi and Syofrianisda [19] learning outcomes are mastery of knowledge, skills, character, and the formation of attitudes and beliefs. Learning outcomes are not only knowledge and skills but also the development of emotions, attitudes, values, aesthetics, and art. The same thing was formulated by Baharuddin and Wahyuni [20], namely, learning outcomes are changes in the learner, both changes in knowledge, attitudes, and skills. With these changes, of course, the perpetrator will also be assisted in solving life's problems and can adapt to his environment. In addition, learning outcomes are also results achieved in the form of numbers or scores by someone after being given a learning achievement test at a certain time [21].

Chemistry is a branch of science that studies the composition and properties of a material, as well as the energy changes that accompany the material [22]. Chemistry broadly includes two parts, namely chemistry as a process and chemistry as a product. Chemistry as a product includes a body of knowledge consisting of facts, concepts, and principles of chemistry. While chemistry as a process includes the skills and attitudes possessed by scientists to obtain and develop chemical products [23].

The reaction of acids and bases to form salt and water is called a neutralization reaction [24]. However, a neutralization reaction does not mean that the salt solution is always neutral. Salt solutions can be formed from a strong acid with a strong base, a strong acid with a weak base, a weak acid with a strong base, and a weak acid with a weak base. The resulting salt solution can be acidic, basic, or neutral. The nature of the salt solution can be explained through the concept of salt hydrolysis.

According to Chang [25], Salt is an ionic compound formed by the reaction between an acid and a base. Salt is a strong electrolyte that dissociates completely in water and in some cases reacts with water. The term salt hydrolysis describes the reaction of the anion or cation of salt, or both, with water. Salt hydrolysis usually affects the pH of the solution.

1.2 Learning Media

Gagne [26] said that media are various types of components that are in a student's environment that can stimulate him to learn. Meanwhile, Briggs [27] said that the media are all physical tools that can present messages and can stimulate students to learn. Miarso [28] said learning media is anything that can stimulate students so that the teaching and learning process takes place.

Learning media functions as a carrier of information from information sources (teachers) to recipients (students). The function of the media can be identified based on the advantages and disadvantages of the media that may arise in the learning process. According to Sadiman, et al [29] the functions of the media in general are as follows: (a) Clarify the presentation of messages so that they are not too verbalistic; (b) able to overcome the limitations of space, time, and senses; (c) appropriate and varied media can overcome the passive nature of students; (d) able to help students and educators in learning and teaching activities.

According to Arsyad [30] said that there are 4 functions in learning media, namely: (a) the function of attention that can attract and direct students; (b) the affective function of visual media can be seen from the level of enjoyment of students during the learning process; (c) cognitive function; (d) the compensatory function of learning media helps students who are weak in reading to organize information in the text and recall it. The rapid development of science and technology is currently influencing the learning process in schools so the learning media to be used must follow the needs of the learning process. Learning media are grouped into four groups, namely as follows: (a) media produced by printing technology; (b) audio-visual technology media; (c) media produced by computer technology; (d) media combined with printing and computer technology.

According to Munadi [31], the types of learning media are as follows: (a) audio media, namely radio, recording devices, and audio tapes; (b) visual media, namely magazines, newspapers, modules, comic posters, and atlases; (c) audio-visual media, namely films, television videos.

1.3 Interactive Media Tutorial Model Based on Concept Hierarchy

According to Prastowo [32] when you hear the word "interactive" one thing that might immediately come to mind is something related to interactions or relationships. According to the Big Indonesian Dictionary, the word "interactive" implies mutual action or inter-relationship, or mutual activity.

According to Daryanto [33] Interactive multimedia is multimedia that is equipped with a controller that can be operated by the user so that the user can choose what he wants for the next process. Examples of interactive multimedia are interactive learning multimedia, game applications, and animated videos.

Jubaeruddin et al. [34] stated that learning media whose elements contain media including text, audio, video, animation, and graphics and allow students, as users to interact through the available features, are called interactive media. Meanwhile, according to Suyitno [35], interactive learning media in the form of text, visuals, and simulations can help students gain more knowledge, deeper understanding of concepts, and know the application of the knowledge being learned.

According to Susilana and Riyana [36], tutorials in learning media are intended as a substitute for tutors (humans) whose learning process is given through text, graphics, sound, video, or animation where students are conditioned to follow a programmed learning path by presenting material and practicing questions. In addition, Roestiyah [37] stated that the tutorial program requires the computer to act as a tutor who leads students through the sequence of material they expect to be the subject which is equipped with appropriate examples and exercises and tests students at each step to check whether students have understood it properly. Good.

This type of tutorial program follows a branching learning pattern where the material will be presented in small units and after each material unit is finished, it ends with a program evaluation which is completed by giving responses to students answers to determine the learning steps for the next material unit [38].

The purpose of the tutorial model is to provide "satisfaction" or complete understanding to students regarding the subject matter being studied [39]. The tutorial program introduces new subject matter to students and is then followed up with practice and practice. This program generally provides pre-tests and post-tests regarding the material (content) presented. The tutorial program is also used as a review of previously delivered lessons to check understanding and increase retention of concepts [40].

The research problem is formulated as follows: Is this interactive media tutorial model based on a hierarchy of concepts valid to be used as a chemistry learning medium on salt hydrolysis material?; Is this interactive media tutorial model based on a hierarchy of concepts practically used as a chemistry learning medium on salt hydrolysis material?; and Is this interactive media tutorial model based on a hierarchy of concepts effectively used to increase students' understanding in chemistry lessons on salt hydrolysis material?

2. METHOD

This type of research is a type of development research commonly called development (Research & Development). Research development is research that aims to produce a product through the development process [41]. According to Borg and Gall [42], the purpose of development research is not only to develop products but more than that to find new knowledge or to answer specific questions about practical problems (through applied research).

This research was conducted at SMA Negeri 1 Karang Baru which is located in the village of Medang Ara, Karang Baru sub-district, Aceh Tamiang district. The implementation time is in the even semester of the 2022-2023 school year. The population in this study were students of class XI MIA which consisted of 4 classes with a total of 110 students. Meanwhile, the sample to be taken was 28 students (1 class). The sample selection in this study used a purposive sampling technique, namely the determination of the research sample based on the consideration of the researcher who considered the desired research elements already exist in the members of the sample taken and based on suggestions from the chemistry study teacher at school.

According to Borg and Gall, there are 10 research and development steps, namely: (1) Potential and problems, (2) Data collection, (3) Product design, (4) Design validation, (5) Design revision, (6) Trial product, (7) product revision, (8) trial use, (9) product revision, and (10) mass production.

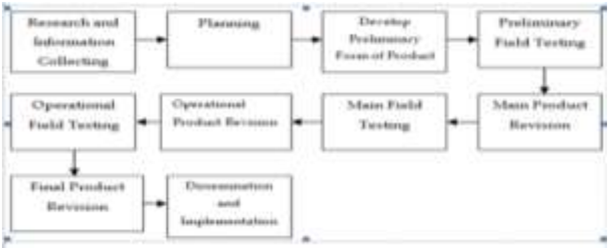

Figure 1. The Borg and Gall Development Model

Meanwhile, the instructional design uses the Dick & Carey model, the steps of which can be seen in the following diagram.

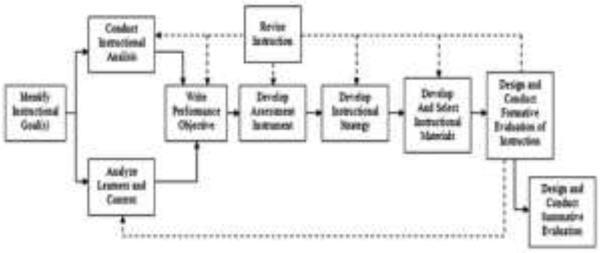

Figure 2. Dick and Carey's Instructional Design Model

Media Validity Data Analysis. Media validity analysis includes analysis of data validation results from Material Experts, Media Experts, and Learning Design Experts. Data collection was carried out using a questionnaire in the form of a Likert scale by distributing questionnaires to respondents, namely the material expert validator, media expert validator, and Learning Design Expert validator. The respondents gave an assessment of the quality of the interactive learning media based on the Concept Hierarchy Tutorial model with the following research criteria:

Table 1. Questionnaire assessment criteria

Criteria	Score
Very good	5
good	4
Enough	3
Not good	2
Very bad	1

(Source: Arikunto [43])

The results of the assessment of each respondent calculated the average score obtained. The average score obtained is then converted into a qualitative value using the formula and basic guidelines to determine the level of validity as follows:

$$P = \frac{\sum x}{\sum x^1} \text{ x } 100\%$$

Information:
P = Large Percentage
$\sum x$ = Number of Validator Answer Scores
$\sum x^1$ = Total Highest Answer Score

Table 2. Media validity classification

No	Percentage (%)	Validity Level	Qualitative Category
1.	80 -100	Very Valid	Not Revised
2.	60 -79	Valid	Not Revised
3.	40 -59	Valid Partly	Partly Revision
4.	20 -39	Invalid	Revision
5.	0 -19	Very Invalid	Revision

(Source: Arikunto [43])

Based on the classification table above, the media is declared valid and suitable for use if the average percentage of media validation given by all validators is ≥ 60%.

Media Practicality Data Analysis. The data obtained from the student response questionnaire were analyzed by determining the percentage of students who gave positive responses for each category asked in the questionnaire. According to Riduwan [44], analyzing student response questionnaires using the following formula:

$$\%Practicality = \frac{\sum value\ obtained}{maximum\ value}\ x\ 100\%$$

Furthermore, the Student Response Value obtained is represented in the following Practicality table:

Table 3. Practicality classification of the media

Interval (%)	Category
81 – 100	Very Practical
61 – 80	Practical
41 – 60	Quite Practical
21 – 40	Less Practical
0 – 20	Not practical

Based on Table 3 of the classification above, the media is stated to be practical and feasible to use if the average value of the percentage of students' positive responses to the media developed is at least 61%.

Media Effectiveness Data Analysis. The effectiveness of learning media is measured through data on the increase in the extent to which targets are achieved from the start before treatment (initial ability test/pre-test) to the target learning outcomes after being given treatment (post-test). The target to be achieved is of course 100% of the material mastered by students, and at least they have reached KKM (Minimum Completeness Criteria) where the KKM value set is 70. To calculate the percentage of Classical completeness scores, the following formula is used:

$$Classical\ Mastery = \frac{Number\ of\ Completed\ Students}{Number\ of\ Research\ Subjects}\ x\ 100\%$$

According to Mulyasa [45], a class is said to have completed learning (Classical completeness) if in that class there are ≥ 85% of students who have completed learning. After the students' classical mastery is analyzed, then to test the effectiveness of the media, manual calculations are used with the N-Gain formula.

The normalized gain test (N-Gain) was carried out to determine the increase in student learning outcomes after being given treatment. The normalized Gain score can be calculated by the following formula:

$$N\text{-}Gain = \frac{SkorPosttest\ score - pretest\ score}{SkMaximum\ score - Pretest\ score}\ x\ 100$$

To see the level of effectiveness of the developed media, the results of the n-gain calculation are then interpreted as follows

Table 4. N-gain Score Classification

N-Gain score intervals	Classification
g > 0,7	High
0,3 ≤ g ≤ 0,7	Moderate
g < 0,3	Low

(source: Hake, 1999)

The interpretation of the effectiveness of the N-gain score on students' learning abilities can be interpreted as follows:

Table 5. Categories of N-gain effectiveness interpretation

Percentage (%)	Interpretation
< 40	Not Effective
40 - 55	Less Effective
56 – 75	Moderately Effective
>76	Effective

(source: Hake, 1999)

3. RESULTS AND DISCUSSION

3.1 RESULTS

The results of assessments by media experts, material experts, learning design experts, small group trials, and limited field trials for all aspects of the assessment are determined by the average score. The results of the assessment are then analyzed and determined whether or not it is appropriate to develop interactive learning media based on the Hierarchy of Concepts Tutorial model. The average percentage of the results of the assessment of media experts, material experts, individual trials, small group trials, and field trials is shown in Table 6 below:

Table 6. Average Percentage of Assessment Results of interactive learning media Tutorial Models based on Hierarchy of Concepts

No	Categorization	Percentage of average score %	Criteria
1.	Material Expert Validation	80,42	feasible
2.	Media Expert Validation	81,94	feasible
3.	Learning Design Validation	83,61	feasible
4.	Small Group Trial	95,33	very feasible
5.	Field Test	89,57	very feasible
Rata-rata		86,17	very feasible

Based on Table 6 above, it can be concluded that interactive learning media products based on the Concept Hierarchy Tutorial model developed include very feasible criteria, thus it is known that the average rating (μo) from experts and field trials is 91.3% while the criterion value the feasibility threshold (μ) is 70%, then μo > μ. So it can be concluded that interactive learning media based on the Hierarchy of Concepts Tutorial model is said to be very feasible to use and can meet the needs of implementing chemistry learning.

The recapitulation of students' pretest-posttest values obtained can be seen in Table 7 below.

Table 7. Students' pretest and posttest scores on salt hydrolysis material

No	test value interval	Pretest		Posttest		Information
		Number of Students	Percent (%)	Number of Students	Percent (%)	
1	0 – 49	10	35,71	0	0	Incomplete
2	50 – 59	2	7,14	0	0	Incomplete
3	60 – 69	1	3,57	4	14,29	Incomplete
4	70 – 79	13	46,43	6	21,43	Completed
5	80 – 89	2	7,14	10	35,71	Completed
6	90 – 100	0	0	8	28,57	Completed
	Total	28	100	28	100	

Table 7 above shows that during the pretest, 10 students scored 0-49 or 35.71%, while 2 students scored in the 50-59 range or 7.14%, while students who scored in the 50-59 range a scored 60-69 1 person or 3.57%, while 13 students or 46.43% of students get scores in the 70-79 range, and finally 2 students or 7.14% of students get scores in the 80- 89.

Table 8 Comparison of students' pretest and posttest classical completeness scores

No	Classical Mastery	Pretest		Post-test		Description
		total	Persentase (%)	total	Persentase (%)	
1	Completed	15	53,57	24	85,71	Increased
2	Incomplete	13	46,43	4	14,29	Decreasing

Based on Table 8 above, the percentage of students' classical completeness in the pretest results was 53.57%, and the number of classical completeness in the post-test results increased, namely 85.71%. Meanwhile, classical incompleteness decreased from 46.43% in the pretest to 14.29% in the post-test. The comparison of the percentage of student completeness in the pretest and post-test is presented in the following diagram 9.

The results of the N-gain calculation can be seen in Table 9 below.

Table 9. Students' N-gain Scores on Pretest and Post-test Scores

Gain score interval	Number of students	Category
$g > 0,7$	3	High
$0,3 \leq g \leq 0,7$	25	Moderate
$g < 0,3$	0	Low

Based on Table 9, it can be seen that 3 students got an increase in the high classification with an n-gain score > 0.7, while 25 students got an increase in the medium classification with an n-gain score at intervals of $0.3 \leq g \leq 0, 7$. While the number of students who got an increase in the low category, namely at a score of n-gain <0.3, was 0 students.

After obtaining the n-gain value for each student, the effectiveness of the media in increasing student test results as a whole can be interpreted based on the acquisition of the n-gain percentage as shown in the following 10 recapitulation table.

Table 10. Interpretation of the effectiveness of N-gain

∑ Students	Pretest		Post-test		∑ *N-gain*	Percentage of N-gain *(%)*	Interpretation
	∑nilai	x̄	∑nilai	x̄			
28	1590	56,78	2255	80,53	0,5634	56,34	Effective enough

Based on Table 10 above, it can be seen that the n-gain percentage value obtained was 56.34%, which means that the media developed was included in the category which was quite effective in increasing student test results on salt hydrolysis material.

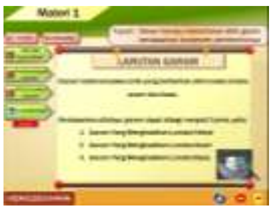

Figure 3. Display of Interactive Media Tutorial Model Based on Hierarchy of Concepts in Salt Hydrolysis Material

3.2 DISCUSSION

Several studies related to the validity of the interactive media tutorial model were found in the results of Yanti and Fatisa's research [46] which stated that the validation of media experts and material experts obtained values of 88% and 88.75% with very valid criteria. The teacher's practicality test got a result of 88.5% with very practical criteria, and the students' practicality test got a result of 86.40% with very practical criteria. Based on these results, this interactive media is very feasible to be used in learning chemistry materials for reduction and oxidation reactions.

The results of Yanto's research [47] that interactive learning media are very practical to use by teachers and students in the learning process of electric circuits. In addition, the results of Saputri's research [48] found that the results of data analysis on the validity of learning multimedia had an average value of Aiken's V of 0.85 with the valid category and the practicality level of the teacher is 88% in the very practical category and the student's practicality level is 86% in the very practical category. The results of the validity and practicality analysis show that the PowerPoint-iSpring learning multimedia integrated with prompting questions developed is valid and practical.

In addition, the results of research by Nelmira, et al [49] showed that the validity test of Interactive CD media was 90.42% (very valid), the practicality test of the media was 94.58% (very practical) and the effectiveness test of Interactive CD media showed an increase in learning outcomes students after using the Interactive CD. So the interactive media for this Embroidery course can already be used in learning.

This is in line with the statement of Wardani et al. [50]) that multimedia tutorials are problem solvers in terms of learning media, by utilizing multimedia tutorials it is proven that they can add positive value to students' learning achievements. Multimedia tutorials include audio-visual in the form of text, images, animation, audio, and video, so that they motivate and make students interested in learning, and can support the achievement of learning objectives [51].

Further results of research conducted by Anggraeni, et al. [52] found that by using the multimedia tutorial program student learning outcomes were more optimal than student learning outcomes without using multimedia tutorials and the percentage value of the experimental class was higher than the percentage value in the controlled class.

The same results were also found in the research of Riasti, et al [53] which stated that the interactive media tutorial model on Impulse and momentum material was very useful in learning and proved to be effective in learning as demonstrated by an increase in KKM mastery of 79%.

4. CONCLUSION

Based on the results and discussion of research on the development of interactive media tutorials based on a concept hierarchy of salt hydrolysis, the following conclusions can be drawn:

1. The interactive media tutorial based on the concept hierarchy developed for class XI chemistry lessons on salt hydrolysis material has met the validity of the very valid category with an average percentage score of material experts of 80.42%, media experts 81.94% and design experts learning 83.61%.
2. Practicality The interactive media tutorial based on the concept hierarchy developed for class XI chemistry lessons on salt hydrolysis material is stated to be very practical with the acquisition of a media practicality percentage score of 89.57%.
3. The effectiveness of the interactive media tutorial based on the concept hierarchy developed for class XI chemistry lessons on salt hydrolysis material on students' learning abilities was obtained through the results of the N-gain test where the average N-gain score obtained was 0.5 (moderate category) or of 56.34% which is included in the quite effective category.

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