



Development of Structured Inquiries-based Live Worksheet with Chemical Representations to Improve Students' Higher Order Thinking Skills

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Abstract: Twenty-first century learning means learning designed for millennials to keep up with modern technology. as a result, it requires students to master four learning skills (4Cs), namely: critical thinking, creativity, communication and collaboration. These four skills support students in the learning process now. This study aims uncover the validity, practicality and effectiveness of structured inquiry-based e-modules that use representation to improve student HOTS. The research means research and development (R&D) and the Plomp development model. The query-based E-Module buffer solution is structured and a 3-layer representation is created based on the Plomp development example, which is divided into 3 stages, namely: preliminary research; prototyping; and the assessment stage. The validity test was analyzed using aiken's V derived formula from which validity will occur obtained 0.85 with the category valid. what will happen is that the structured inquiry-based buffer solution module is valid and easy to use for chemical learners.

Keywords: e-modules, buffer solutions, live worksheets, multiple representations, structured inquiry

Abstrak: Pembelajaran abad 21 artinya pembelajaran yang dirancang buat generasi abad 21 supaya bisa mengikuti perkembangan teknologi modern. sebagai akibatnya menuntut siswa buat menguasai empat keterampilan belajar (4C), yaitu: berpikir kritis (Critical Thinking), kreativitas (Creativity), komunikasi (Communication) serta kolaborasi (Collaboration). Keempat keterampilan ini mendukung siswa pada proses pembelajaran abad 21 mereka. Penelitian ini bertujuan buat mengungkap validitas, praktikalitas dan keefektifan e-modul berbasis inkuiri terstruktur yg memakai representasi uuntuk meningkatkan HOTS peserta didik. Penelitian tersebut artinya penelitian serta pengembangan (R&D) dan model pengembangan Plomp. Solusi buffer E-Module berbasis query terstruktur dan representasi 3 lapis dibuat berdasarkan contoh pengembangan Plomp, yg dibagi menjadi 3 tahap, yaitu: penelitian pendahuluan; termin prototyping; dan tahap penilaian. Uji validitas dianalisis menggunakan rumus Aiken's V berasal yang akan terjadi validitas diperoleh 0,85 dengan kategori kevalidan sangat valid. yang akan terjadi penelitian menerangkan bahwa modul larutan penyangga berbasis inkuiri terstruktur sudah valid serta mudah saat dipakai buat pembelajara kimia.

Kata kunci: e-modul, larutan penyangga, live worksheet, multipel representasi, inkuiri terstruktur

▪ INTRODUCTION

The learning process used to create meaningful learning is to use multiple representations to facilitate learning. Multiple representations have three levels in learning applications, namely macroscopic, submicroscopic, and symbolic levels (Johnstone, 2000). Multiple chemical representations can be used as tools or tools to support and facilitate meaningful learning and the occurrence of deep learning (macro,

micro and symbolic) and the relationship between the three levels (Jaber et al., 2011). However, in its application, the use of such chemical representation multiples is still limited to the macroscopic and symbolic levels. Presumably, the application of the three representation levels should not be separated, as learning by connecting the three levels improves conceptual understanding (Sari and Seprianto, 2018).

High order thinking skill (HOTS) is a skill to connect, change knowledge and experience possessed critically and creatively to determine decisions in solving problems in a situation (Barak et al., 2009). The purpose of this learning process is to change students' thinking skills from low order thinking skills (LOTS) to high order thinking skills (HOTS). High order thinking skills or commonly called High order thinking skills (HOTS) In addition, thinking with high order thinking skills will help students solve new problems even though they are related to old knowledge (Suarsana, 2013).

Electronic modules or commonly referred to as E-Modules. The e-module can be accessed with the help of a computer that is already integrated with software that supports accessing the e-module. The e-module is a complete unit consisting of a series of learning that is systematically arranged to achieve certain learning objectives displayed using electronic devices. Inside it can contain images, text, videos, animations and more. The use of electronic modules is not only practical, but can also improve higher-order thinking skills as well as give a positive impression of students (Fajaryati et al., 2016). The use of e-modules can support learning in accordance with the 2013 curriculum, namely a student-centered learning process. This means that in the learning process the student is no longer the recipient but rather the student himself who will investigate the concepts he will learn (Sagita et al., 2017)

Buffer answer fabric is fabric associated with the previous cloth, namely acid base. A buffer solution is a solution which could hold a sure pH to trade pH consisting of the addition of acid, base or dilution, in other phrases the pH of the buffer answer will no longer change significantly despite the fact that a bit robust acid, sturdy base or the answer is diluted. (Petrucci, Harwood, 2007). The buffer solution for the material taken into consideration through college students is hard to apprehend in order that it could prevent college students in information the lesson. to overcome this, an answer is needed in coaching substances to make it less difficult for college kids while studying in order that a learning version is needed which can teach college students' thinking techniques through using a systematic approach, considered one of which is established inquiry (Sari, 2018).

The structured inquiry getting to know model is a part of the inquiry getting to know model. established inquiry is suitable to be used within the technology getting to know technique (Bunterm et al., 2014), and also can create a significant learning method due to the fact it may make students do not forget data longer and more constantly (Schmid and Bogner, 2015). In a established inquiry getting to know version students are given questions, issues, methods and information analysis but are not given conclusions and the final result of the trouble (technological know-how and standards, 2000). students are required to investigate those questions and problems so that scholars are concerned extra all through the gaining knowledge of process. this is so that students are in a position to relate these problems and questions with the outcomes of the

findings acquired so that students better recognize a concept and are capable of don't forget it for a longer time (Bel, 2005)

Based on the explanation of the problem above, the writer wants to behavior studies to broaden an progressive teaching material inside the form of e-modules and worksheets on a structured inquiry-primarily based live worksheet the usage of more than one chemical representations with the title "development of an E-Module Buffer solution with Worksheets on stay Worksheets. structured Inquiry-based the usage of more than one Representations to enhance (HOTS) students"

▪ **METHOD**

The development model used on this look at is the Plomp model evolved by Tjreed Plomp. This version includes three ranges, namely preliminary research, prototyping and assessment phase (Plomp, 2007).

The research subjects are individuals who are used as a source of information needed in data collection. The subjects of this trial were lecturers of the chemistry department of FMIPA UNP, high school chemistry teachers and class XI students of SMAN 1 Padang and SMAN 14 Padang. The population used for research data for class XI students of SMA N 1 Padang and SMA N 14 Padang students was 40 people. Each school consists of 2 classes, namely: experimental class and control class

Studies subjects are folks who are used as resources of statistics wanted in facts series. The subjects of this trial had been lecturers within the chemistry branch of FMIPA UNP, excessive faculty chemistry teachers and sophistication XI college students at SMAN 1 Padang and SMAN 14 Padang. The studies on the improvement of a buffer answer e-module with worksheets on a established inquiry-based totally stay worksheet using more than one chemical representations to boom scholar Hots in SMA/MA become accomplished in magnificence XI of SMAN 1 Padang and SMAN 14 Padang inside the even semester of the 2021/2022 educational 12 months (Purba, 2007).

The technique of analyzing the validity of content, design, and practicality is based on modified categorical judgments (Bouslough, 2008). On the validation sheet the validator is given a statement and the validator gives an assessment of the statement. At the end, validators are given the opportunity to decide the results of the assessments that have been given.

The method used to analyze the validity of the construct is to use Aiken's V. Validator's assessment of each statement is analyzed using the formula Aiken's V. Formula of aiken's V can be written as follows:

$$v = \frac{\sum s}{n(c - 1)}$$

Information: $s = r - I_0$; I_0 = low validity score; c = highest validity rating score; r = the number given by an appraiser; n = number of validators (evaluators).

The validity of the teaching materials used is seen from the resulting V value if $V < 0,8$ invalid teaching materials but if $V \geq 0,8$ valid teaching materials. This practicality check is finished after it's far stated that the device has met the eligibility requirements. Practicality check is used to decide the practicality of the usage of an device, so that the tool is realistic to use. There is practicality take a look at sheets used, namely: practicality take a look at sheets in step with teachers and practicality test sheets in

keeping with college students.

If the number of raters is more than two, the analysis used is a Likert scale. Processing using a Likert scale with the following formula:

$$\text{Practicality value} = \frac{\text{the number of scores obtained}}{\text{maximum number of scores}} \times 100\%$$

Tabel 2. Degree of practicality

Interval	category
0 – 20	Very impractical
21 – 40	Not practical
41 – 60	Less practical
61 – 80	Practical
81 – 100	Very practical

Evaluation of effectiveness records acquired from student mastering outcomes assessment sheets by using engaging in pretest and posttest analyzed the N-gain equation decide of effectiveness of dependent inquiry-based e-modules with worksheets on live worksheets using multiple representations to increase college students' HOTS. evaluation of learning results checks is primarily based on information on student gaining knowledge of check effects inside the cognitive area. The reality of the studies consequences is done through checking out the speculation.

▪ **RESULT AND DISSCUSSION**

This studies includes 3 stages, specifically the initial research stage, the producing level (prototype phase) and the assessment stage (evaluation phase). at the initial research degree, the researcher conducts numerous analyses, namely, wishes evaluation, curriculum analysis and concept analysis. The needs analysis became performed via interviews with instructors and students on the buffer answer learning fabric. Interviews are conducted with the goal of knowing the issues of the scenario that occurs at college, along with learning strategies carried out by using instructors at faculty, troubles, the use of coaching materials, motivation in gaining knowledge of, and problems skilled all through the studying process. based totally at the outcomes of the interview, it is regarded that buffer fabric is one of the materials this is considered tough by students. this is because many contain calculations. The coaching substances used in schools also do not display tons macroscopic degree and nevertheless display little submicroscopic level (Purba, 2007).

Throughout the primary segment of the research, the researchers conducted numerous analyses, specifically, wishes analysis, curriculum evaluation, and conceptual analysis. A wishes evaluation is carried out thru interviews with instructors and college students of the acid-base learning substances. The purpose of undertaking the interview is to understand the problems that stand up inside the college, inclusive of b. The getting to know strategies used by the college teachers, the troubles, using coaching substances, the incentive for studying and the difficulties encountered in the mastering procedure. From the interview outcomes, it is able to be seen that the buffer material is one of the substances that students do not forget to be hard. That is due to the fact many involve

computation. Further, the textbooks used in faculties do now not show lots on the macro stage and little or no on the sub-micro stage (Kurniawati, 2018).

At the prototype stage, there are 4 prototype levels carried out, particularly: prototype 1, prototype 2, prototype 3, and prototype four. Prototype 1 is a prototype acquired from the effects of the layout and research tiers that have been performed. Prototype i was advanced inside the shape of a based inquiry-based acid-base e-module using three tiers of chemical representation organized in keeping with the established inquiry syntax. The additives of the designed e-module are cowl, hobby sheet based totally on established inquiry syntax, worksheet. the subsequent is an outline of those additives in Figure 1

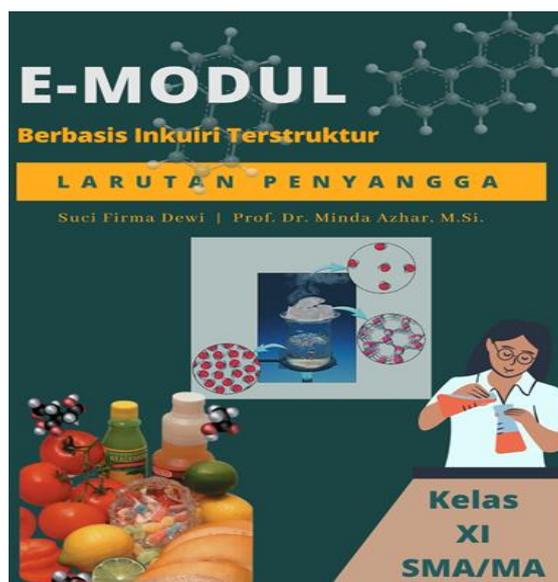


Figure 1. Cover

The e-module cover segment is in accordance with the 2017 e-module practise tips from the Ministry of training and way of life, particularly the quilt as an identification of the e-module have to contain name the e-module, problem name, topic/mastering material, magnificence or goal so one can use the e-module. and the writer of the e-module cover designed with appealing colors with a view to arouse students' interest in studying and analyzing it. (Monica, 2011). furthermore, the interest sheet, that is arranged primarily based at the syntax of dependent inquiry, can be seen in parent 2:

KOMPOSISI LARUTAN PENYANGGA

OBSERVASI

Ananda sudah paham konsep asam dan basa pada materi sebelumnya. Nah, bisakah anda bayangkan bila tubuh manusia dimasuki zat yang mengandung asam atau basa? Tentu saja jika tubuh manusia pH-nya tiba-tiba naik atau turun drastis akibat masuknya larutan asam atau basa maka akan sangat berbahaya hingga menyebabkan kematian. Tubuh manusia harus selalu tetap dijaga keseimbangan atau pH-nya. Menjaga keseimbangan pH larutan penyangga, maka tubuh manusia harus memiliki sifat sebagai larutan penyangga atau *buffer*. Dengan adanya sifat larutan penyangga, maka tubuh manusia dapat mempertahankan pH walaupun menerima berbagai penambahan zat yang mengandung asam atau basa.



Gambar 5. (a) Asam Lemah dan (b) Garam
(<https://www.google.com/search?q=cuka+makanan>)

Figure 2. Observation stage

E-Modul Inkuiri Terstruktur



HIPOTESIS

Berdasarkan video tersebut coba anda kemukakan

1. Asam dan basa menurut Bronsted-Lowry;
2. Asam dan basa konjugasi menurut Bronsted-Lowry
3. Pengertian larutan penyangga;
4. Komponen larutan penyangga;
5. Prinsip kerja larutan penyangga.

Klik Di sini Untuk Hipotesis (Waktu 10 Menit)

KOLEKSI DAN ORGANISASI DATA

1. Definisi Larutan Penyangga
 a. Larutan Penyangga Penambahan Basa
 Dalam tahap observasi telah dibahas mengenai asam lemah dan basa lemah, dimana asam lemah dan basa lemah tidak pernah terionisasi sempurna dalam air. Jadi pada kesetimbangan larutan asam lemah misalnya, mengandung asam yang tidak terionisasi dan sebagian ion H⁺ sebagai basa konjugasi. Keseimbangan yang terjadi pada asam basa dengan mempertimbangkan larutan penyangga (*buffer*). Perhatikan dengan seksama Gambar 8 dan Gambar 9 kemudian jawablah rangkaian pertanyaan dengan teliti:

Gambar 8. Ilustrasi larutan penyangga $\text{CH}_3\text{COOH}/\text{CH}_3\text{COONa}$ dengan penambahan merkuri orange (a) penambahan dengan air, (b) penambahan dengan NaOH (Brady, 2012 : 818)

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Figure 3. Hypothesis stage and data collection and organization

After obtaining prototype I, self-evaluation is performed to produce prototype II. This self-evaluation specializes in discrepancies that appear along with incompatibility of typing letters, the use of pix, completeness of e-modules including factors that have to be owned by way of e-modules, and completeness of degrees of dependent inquiry getting to know fashions. Grid of self-assessment sheets In preferred, many upgrades have been made to the font length and mistakes in writing. After self-evaluation and revision, Prototype II is obtained.

Prototype III resulted from expert overview (expert evaluation) and person evaluation (one to one) of prototype II. The prototype II that has been produced is confirmed by experts (chemistry academics and chemistry teachers) and an person assessment (one to at least one) is accomplished with 3 students of sophistication XI SMA. After revision, prototype III is produced.

Professional assessment is carried out to acquire scientifically valid prototypes in phrases of content material, construct, language and snap shots used. The effects of the expert assessment of the prototype II acquired a degree of validity. Validation become performed via six validators which include three chemistry teachers and three chemistry instructors. The additives assessed by the validator include four components, namely content material components, assemble additives, linguistic additives and pictures. each element has a statement object crammed in by using the validator which can be visible in table 1

Table 1. Results of e-module validation analysis

Rated aspect	V	Category
Content Component	0.84	Valid
Construct Component	0.87	Valid
Language Component	0.90	Valid
Graphic Components	0.89	Valid
Value (V) Average	0.88	Valid

Table 1. provides information that the average price of the validity of the E-module indicates that the e-module that has been designed has a legitimate class with a median Aiken'V value of 0.88. The effects of the stepped forward prototype II will produce prototype III. This prototype III turned into examined on college students in small

Corporations totaling 9 people from SMAN 1 Padang with 3 human beings with excessive competencies, three people with mild abilities and 3 human beings with low abilities, and accompanied by using a revision level. The outcomes of the questionnaire on prototype III inside the small group test can be seen in table 2

Table 2. Results of the small group stage e-module practicality questionnaire

Items	Rated aspect	V	Category
1-2	Attractiveness	90	Very Practical
3-10	Ease of Use	89	Very Practical
11-12	Time efficiency	92	Very Practical
13-15	Benefit	91	Very Practical
	Overall Practicality	90	Very Practical

Practicality of E-Module From trainer response Questionnaire filled out via three chemistry teachers after learning using e-module. The aspects assessed are beauty, ease of use, performance of gaining knowledge of time, benefits, and clinical reality. This trial become carried out at SMAN I Padang. The outcomes of processing the chemistry trainer subject test questionnaire may be visible in the appendix. The effects of the IV prototype take a look at for chemistry instructors may be visible in table 3.

Table 3. Results of practical teacher field test

Items	Rated aspect	V	Category
1	Attractiveness	83	Very Practical
2-6	Ease of Use	87	Very Practical
7-8	Time efficiency	79	Very Practical
9-12	Benefit	90	Very Practical
13-16	Scientific Truth	90	Very Practical
Overall Practicality		85	Very Practical

Table 3. Pronounced realistic fee of buffering answer younger's modulus vs. Live structured query-based worksheet the usage of multiple graphs to improve pupil hots became reported as very practical, with an average percentage of 85%. The reason of a huge set of assessments isn't always handiest to recognize the practical applicability of the elastic modulus, however also to determine the validity of the designed elastic modulus. The effectiveness of this e-module can be seen within the impact of using the e-module on learning results and students' thinking abilities. The test turned into performed in two schools, SMAN 1 Padang. Sampling the use of focused sampling strategies. Practicality of the E-Module from scholar response Questionnaires became tested on college students of SMA N 1 Padang. The pupil response questionnaire was filled out via forty college students from SMAN 1 Padang after gaining knowledge of. The outcomes of the e-module practicality information analysis at the sector test degree as an entire are indexed in desk 4.

Table 4. Practical results of student e-module field test stage

Items	Rated aspect	V	Category
1-2	Attractiveness	85	Very Practical
3-10	Ease of Use	91	Very Practical
11-12	Time efficiency	93	Very Practical
13-15	Benefit	93	Very Practical
Overall Practicality		91	Very Practical

The effectiveness of the advanced e-module is seen by way of comparing learning results and better order thinking abilities inside the experimental class and the control elegance. The experimental magnificence learns to use the e-module and the manipulate magnificence without the e-module. earlier than getting to know begins, a pretest is accomplished to decide the scholars' initial talents. After mastering is achieved in every magnificence, after that a posttest is done the usage of the same questions.

After the normality check and homogeneity take a look at were performed, it became found that the statistics from the 2 colleges were typically allotted and had a homogeneous variance, so the t-check become used to test the hypothesis. so that the t-check is used to check the hypothesis with the help of SPSS software. The results of the t-test are summarized in desk 5.

Table 5. Hypothesis test results

Class	N	α	Sig.(2-tailed)	Information
Experiment	40	0.05	0.000	Reject H ₀
Control	40			

Table 5. Indicates that, the significance fee obtained from speculation checking out for student gaining knowledge of effects (sig. = 0.000) is also smaller than 0.05 so that H_0 is rejected and H_1 is prevalent. that is, there's an impact of the use of e-modules on scholar studying consequences within the experimental class and control elegance. The importance value acquired is zero.039 on the 95% confidence degree with a importance degree ($\alpha = \text{zero.05}$). The significance fee is less than zero.05 so that H_0 is rejected and H_1 is commonplace. that is, there's an impact of the use of e-modules on student gaining knowledge of effects inside the experimental elegance and control magnificence (Bunterm., et al 2014).

▪ CONCLUSION

Thru the research that has been finished, it turned into discovered that the dependent inquiry-based buffer answer module for sophistication XI SMA makes use of an R&D improvement version. The enhanced e-module has a totally high level of validity in order that it can be used inside the getting to know process, the factor price is zero.69, the assemble aspect price is zero.sixty eight, the linguistic factor cost is zero.70 and the image element fee is zero.69 based at the provisions of Aiken's V class. of the e-module buffer answer is legitimate. The e-module has been declared legitimate in terms of content and constructs and may be tested for its practicality and effectiveness.

The effectiveness of the e-module is visible from the contrast of student gaining knowledge of effects inside the experimental class (which uses based inquiry-based e-module buffer answer) and the manage elegance (which does no longer use based inquiry-based e-module buffer solution). hypothesis checking out suggests that there's a great distinction among the learning results of the experimental and manage classes with a ninety five% self belief stage with a importance level (α) of 0.05 in faculties with high pupil talents as well as schools with moderate student skills. The ensuing e-module can enhance students' higher order wondering skills on acid-base material. In general, the high-order questioning capabilities of the experimental class college students have been better than the control elegance each for faculties with high-capacity college students and faculties with moderate-ability students.

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