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Development of Virtual Laboratory Inorganic Chemistry of Main Elements Based on Blended Learning Using Pogil Strategy

Kusumawati Dwiningsih*, Sukarmin, Muchlis and Dina Kartika Maharani
Departement of Chemistry
Universitas Negeri Surabaya
Surabaya, Indonesia
kusumawatidwiningsih@unesa.ac.id

***Abstract*— This research has the objective to determine the feasibility of virtual laboratory-based *blended learning* developed in the materials of inorganic chemistry of main group elements in terms of the validity of the quality of the content and purpose, construct, instructional, and technical. The type of research used is a research development with research procedures based on the Borg and Gall Model. The target of this research is students of the Department of Chemistry, Surabaya State University. The results of this study can be concluded that the virtual laboratory feasibility is based on *blended learning* developed in the inorganic chemical material, the main group elements in terms of validity by using the instrument of validation sheet on the media in the form of laboratory virtual media on inorganic chemical material, the main group elements where the overall aspects of quality and purpose, construct, instructional, and technical aspects get the percentage overall of 85% and *e-learning website* as a support for *blended learning* learning activities obtained an overall percentage of 81% with very valid / feasible criteria as a *blended learning* based learning media using POGIL strategies.**

Keywords—Virtual laboratories,* Blended Learning, *POGIL strategies, inorganic chemistry main group elements

I. INTRODUCTION

Practicum activities conducted in the laboratory are one of the testing activities, namely testing physics, chemistry and microbiology. Data obtained from the test results must be traceable and valid. So that it can be used as: 1) the basis for making policy and planning decisions in environmental management; 2) indications of indications of environmental pollution and 3) important evidence in environmental law enforcement [1] [2].

Chemistry is knowledge that is based on experiments, where its development and application become the standard of experimental work. The materials used in chemical laboratories are classified as special ingredients, such as bromide, Pb, Hg, chloroform, I2, and others. While chemicals classified as general ingredients are glucose, NaCl, sucrose, cooking oil, carbon rods and so on [3].

Based on the Inorganic Chemistry Practicum Guidance of the Department of Chemistry FMIPA Unesa, the use of chemicals in a special category in the practice of inorganic chemistry occurs almost in every practicum title. Practicum materials for special categories are very dangerous to human health. For that understanding of the use of chemicals special categories must be known by each practitioner [4].

At this time with the development of technology that is already very advanced it is not difficult for students to conduct their own experiments using a virtual laboratory that is free of charge. The selection of virtual laboratories as learning media is because the virtual lab media can be designed and developed according to the conditions and situations of learning activities that will be faced. Therefore, the development of a virtual laboratory model design as a medium of learning in the learning process is needed [6].

Virtual lab certainly cannot be used to replace practicum activities in the actual laboratory because practicum activities in a virtual lab cannot train students' process skills which will only be obtained from practicum activities in the actual laboratory, but this virtual lab can be used as learning media that can help students in understanding the material to be studied [5].

Virtual laboratories are one of the latest ICT technology-based learning media tools, in the form of integrated systems through computer networks. This virtual laboratory is included in the category of E-Learning where through virtual laboratories students can get to know the nature of chemicals before interacting with chemicals directly. However, practicum activities through virtual laboratories still have drawbacks, namely the success of virtual laboratory assisted learning depends on the independence of students to follow the learning process, and students still need real practicum that they can macroscopically observe directly [7] [8].

By paying attention to the advantages and disadvantages of practicum learning through virtual laboratories, Blended Learning based learning is needed which is a learning method that combines classroom-based learning systems (face to face) and e-learning based learning, namely by utilizing electronic media. That is, the learning process of face to face methods is supported by e-learning. So that interactive and the benefits of learning can be achieved optimally. Learning with e-learning can make learning more effective [9] [10].

To realize this, it is necessary to apply the principle of education with a virtual laboratory model design based on Blended Learning. By applying the Blended Learning method, it allows users of online learning resources especially those that are web-based without leaving face-to-face activities. The main learning activities are practicum in real. While the function of the internet is to provide enrichment and communication between students and lecturers, fellow students or students with other speakers [11].

The increasingly rapid development of Information Technology (IT) has triggered the emergence of new applications that can be used to encourage discovery and innovation in various aspects of life, one of which is in the field of education [9]. Learning models that can support learning in the material are POGIL strategies.

POGIL (process oriented guided inquiry learning) strategy or process oriented guided inquiry are learning strategies that provide opportunities to understand content and process skills simultaneously [12]. One of the advantages of the POGIL strategy is a learning model that emphasizes the development of cognitive, affective, and psychomotor aspects in a balanced manner. Through learning using the POGIL strategy can improve student cognitive learning outcomes, while the use of blended learning will increase student activity and communication between teachers and students as well as between students themselves. Through the POGIL strategy students can be actively involved in learning and interacting with lecturers and with other students, where the lecturer is only a facilitator [13].

In this study the chemical concept that will be conveyed is the concept of Inorganic Chemistry Practicum. This concept studies how the application in the laboratory of the main group elements. The concept of inorganic chemistry practicum is felt to fulfill three basic principles in determining content, namely: (1) The concept being tested must be relevant to real life situations, (2) the concept of inorganic chemistry practicum is expected to continue to be used for at least the next decade; and (3) The concept must be related to process competence.

Based on the background description, the purpose of this study is to focus on how the feasibility of developing a laboratory for virtual inorganic chemistry, the main group elements based on blended learning with a POGIL model.

II. METHOD

This type of research is a development research with research procedures adapting Borg & Gall's educational research and development model. The instructional development model of Dick & Carey (2001), and the Cennamo and Kalk development model, was proposed by a virtual laboratory development model in this study as in Fig. 1.

This research will be piloted in the Department of Chemistry at the State University of Surabaya in the odd semester of the 2017/2018 school year. Take one class of Chemistry Education in 2015 consisting of students from upper, middle and lower groups in terms of students' academic abilities.

The research instrument used in collecting data on research are Instrument sheets and sheets validation study. The instrument review and validation sheet is the instrument used to review and assess laboratory virtual media conducted by chemistry lecturers to provide input and suggestions on virtual laboratory media. Conformity of constructivist virtual laboratories with linguistics, graphics, and illustrations/drawings. Compatibility of virtual laboratory content with basic competencies and indicators. The empirical compatibility of virtual laboratories with student readability, student response, learning outcomes and student activities.

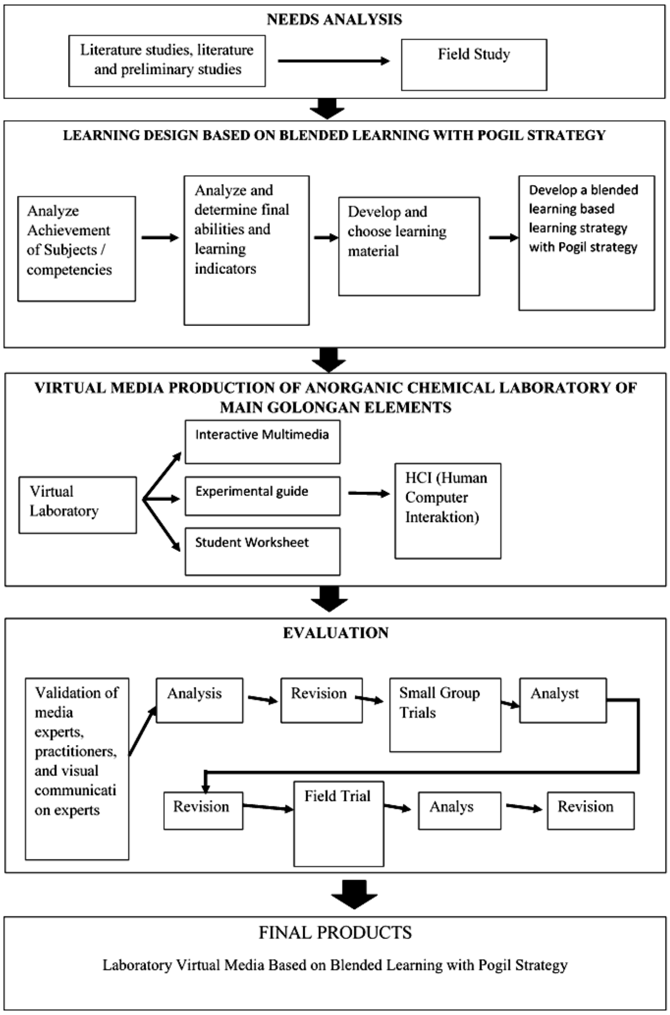

Fig. 1. Steps of the laboratorium virtual development model

The validation results of data were analyzed quantitatively-descriptively. The results of the analysis of each criterion will be presented in the form of a percentage based on the Likert scale in Table I.

TABLE I. LIKERT SCALE

Category	Scale
Very good	5
Good	4
Medium	3
Bad	2
Very bad	1

The formula used in calculating the validation results to download percentages is:

$$\% = \frac{\textit{score total all validator every criteria}}{\textit{criterion score}} \times 100\%$$

Criterion score = highest score per item x number of respondents. The results of the calculation are interpreted in accordance with Table II.

TABLE II. INTERPRETATION CRITERIA SCORE

Scale	Category
0% -2%	Very bad
25% -40%	Bad
41% -60%	Medium
61% -80%	Valid
81% -100%	Very valid

[5]

III. RESULT AND DISCUSSION

A. *Needs Analysis Phase*

At this stage the aim is to analyze the needs or conditions of learning. Needs analysis has the purpose of raising the basic problems needed. The search for the basic problem stated in the research is indicated by empirical data, namely through investigation. P Collecting this data is done by using literature studies, literature and the study of the introduction is through observation, interviews, and questionnaires. The consideration of needs analysis is the applicable curriculum in the Department of Chemistry, Surabaya State University.

This stage the researcher identifies the procedure to determine the lecture material that will be taught to students. Task analysis is carried out to compile the content of teaching material in outline. This analysis is carried out by detailing the content of teaching media obtained based on the applicable curriculum, namely the curriculum that applies in the chemistry department of Surabaya State University. In addition, it also analyzes the concepts carried out to identify the concepts being taught. The concept taught is a concept related to inorganic chemistry of the main group elements. Concept analysis can be seen in the basic competencies which are then made a learning indicator.

B. *Design Phase*

The *design* phase is carried out with the aim of planning about the media and learning tools that will be developed relating to the analyzes that have been carried out in the needs analysis stage. *Blended learning* based learning devices are basically used to improve the quality of learning outcomes [14] [15].

The main product developed in this research is laboratory virtual *software* that is made using *Adobe Flash CS3 Professional* and produced learning media products in the form of *".exe"* or *"SWF"* format.

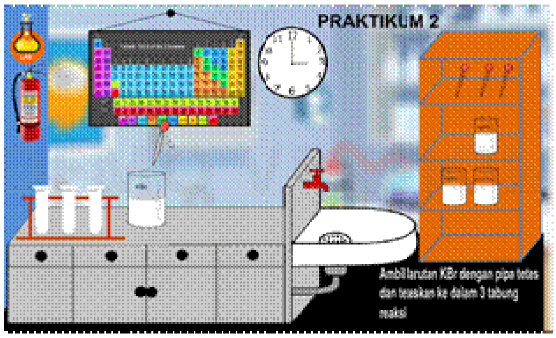

Fig. 2. Excerpt of Draft I Virtual Laboratory of Halogen Material

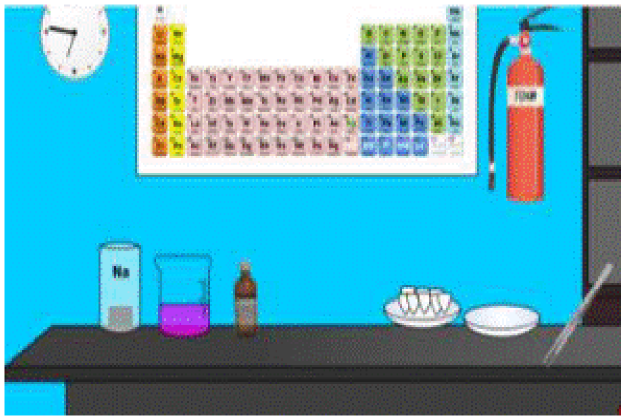

Fig. 3. Excerpt of Draft I Virtual Laboratory for alkaline Material

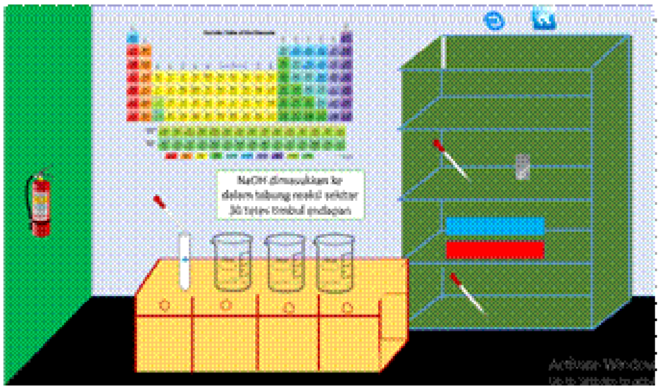

Fig. 4. Excerpt of Draft I Virtual Laboratory for Aluminum Material

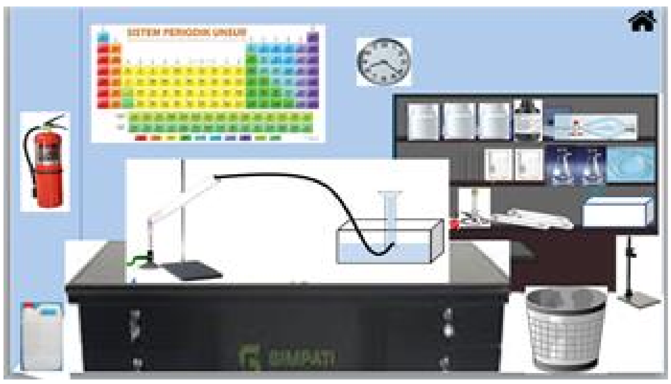

Fig. 5. Excerpt of Draft I Virtual Laboratory for Oxygen Material

The developed virtual laboratory is a virtual laboratory based on *blended learning*, so that learning using multimedia can be done when the student conducts *online* activities using the *website* https://vi-learn.unesa.ac.id/course/view.php?id=%202310*Offline* learning is done in the classroom by conducting discussion together. The learning process with *blended learning* will be more effective and efficient because this learning process combines harmoniously between *online* -based learning and *offline* learning. This can facilitate students in accessing subject matter from *web-learning* that can be done in an unlimited time and place [16].

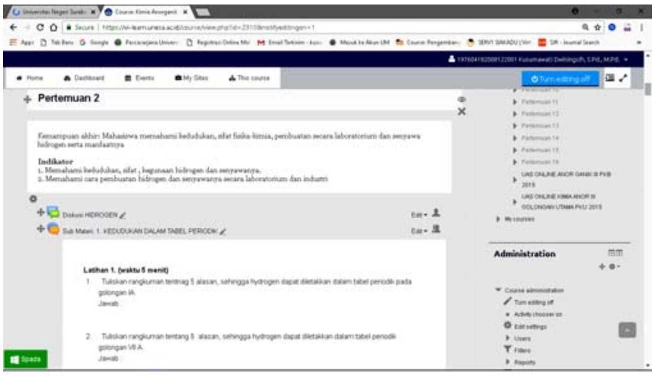

Fig. 6. Designing of Vi-Learning online activities

C. Production Stage

Blended learning based on virtual laboratory learning with the pogil model developed is in the subject of inorganic chemistry, the main group elements. Products developed using *macromedia flash* for simulations that can support laboratory virtual activities. The results of the development are in the form of system design. For design, the following steps are needed,

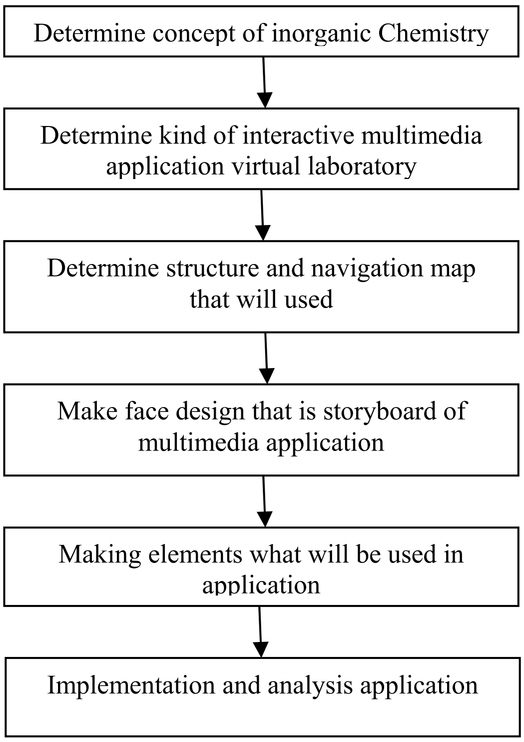

Fig 7 .System design steps

In the practice of inorganic chemistry, sometimes the virtual environment is used visually to investigate whatever happens to physical world events that are being observed, moreover the form of molecules that are not visible to the eye need to be simulated. One of the senses that is widely used to get information from the environment is vision. The sense of sight is used more than other senses in processing information.

Some psychological research shows that more information can be understood when presented in a visual form, compared to non-visual presentation. Virtual based learning especially in practicum activities can reduce costs compared to conventional training. The need for expensive practical equipment and materials in real laboratories, or additional equipment for practical activities can be reduced. The advantage of using virtual-based practicum media as a training tool is; (1) reduce the practicum time in the actual / real environment, (2) can practice in dangerous conditions and require research that can cause damage to materials or practicum tools, (3) save costs through the same practicum.

D. Evaluation Phase

The *evaluation* phase is a stage that aims to produce development products. Activities carried out at this stage are review, validation, revision, and limited trials.

After the first draft in the form of a product design draft was made consisting of virtual laboratories, *vi-learning*, and the MFI was completed, the next stage was media review. The media was reviewed by material experts and media experts, namely chemistry lecturers. The results of *blended learning* based on laboratory virtual studies by chemistry lecturers and media experts obtained several suggestions that can be used to improve and produce *draft II. The second draft,* which was produced, was then validated by a chemistry lecturer, and media experts to get valid results and were suitable for use as learning media.

The results of this study concluded that the virtual laboratory feasibility based on *blended learning* was developed in the inorganic chemistry material of the main group elements in terms of validity by using the instrument validation sheet in the media in the form of a virtual laboratory where the overall quality of the content and objectives, constructs, instructional, and technical obtained the overall percentage of 85% and *e-learning website* as a support for *blended learning* learning activities gained an overall percentage of 81% with very valid / feasible criteria as a *blended learning* based learning media . Here are the results of the analysis of each quality:

1) Quality of content and purpose

There are several aspects in evaluating the quality of the content and objectives that are validated.

a) Learning Media in the Form of Virtual Laboratories

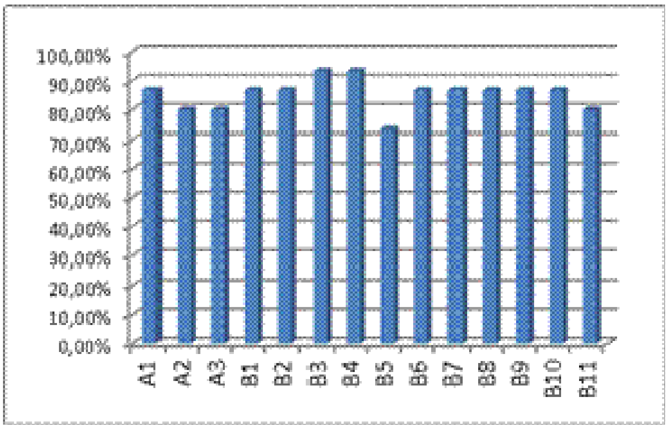

Fig. 8. Media Content Validation and Purpose Validation Graph

Graph description validation of quality and purpose aspects:

A1: Conformity Purpose of learning the material of the main group elements with *blended learning* based laboratory virtual

A2: Conformity Learning objectives with basic competencies of the main group elements include virtual laboratories: "Learning Objectives"

A3: The link to science and technology on *blended learning* based laboratory virtualization is made

B1: Compatibility of concept maps in virtual laboratories with the concept of main group elements including virtual laboratories: "Concept maps"

B2: Conformity of understanding presented with the concept of virtual laboratories includes virtual laboratories: "Understanding"

B3: The suitability of the properties presented with the concept of inorganic chemistry of the main group elements

B4: Suitability of the properties presented with the virtual concept of the laboratory

B5: The illustrations used in virtual laboratories based on *blended learning are* clear, relevant, and accurate

B6: Animations in a virtual laboratory can facilitate understanding of material
Virtual laboratories: Hydrogen "animation"

B7: Virtual laboratories: "Animation" Oxygen

B8: Virtual laboratories: Aluminum "Animation"

B9: Virtual laboratories: Halogen "Animation"

B10: Virtual laboratory: Alkali "Animation"

B11: Compatibility of practicum videos on virtual laboratories with the concept of inorganic chemical material main group elements include virtual laboratories: "Practicum Videos"

b) E-Chemical website

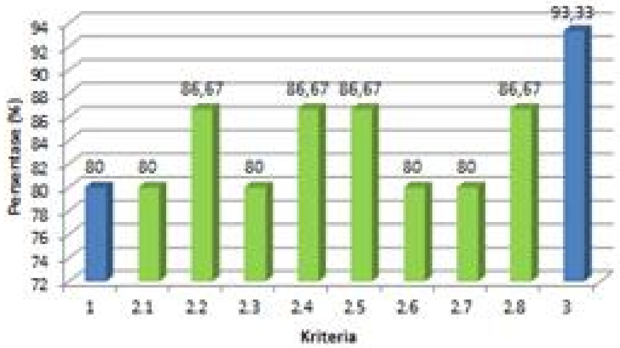

Fig 9. Content Validation Graph of *Website* Content and Purpose

Graph description validation of quality and purpose aspects:

1 The consistency of presentation in *e-learning* media includes activities using the *POGIL* model

2.1 The learning activities within the *website* used in developing virtual laboratories based on *blended learning are* clear, relevant, and accurate
Activity "Reading Phenomenon"

2.2 "Problem Formulation" Activity

2.3 " *Downloading a* virtual laboratory" activity

2.4 "Hypothesis" Activity

2.5 "Discussion" Activity

2.6 "Work Steps" Activities

2.7 "Discussion Result" Activity

3 *E-learning* media can overcome time constraints

Based on the results of the graph above, the assessment of the quality and purpose of obtaining the overall percentage for the virtual laboratory is 85.64% while for *the e-chemistry website it is* 84%. According to Riduwan [10], this percentage is classified as very valid. So the *blended learning* based laboratory virtual is said to be very valid / feasible. According to the National Education Standards Agency / BNSP [15], the feasibility related to the quality aspects of the developed learning media is said to be valid or feasible when viewed in terms of material and the truth of the concepts presented as need to be considered is the relationship between indicators / learning objectives with the material presented.

2) Construction Quality

There are several aspects in construct quality assessment that are validated, namely Learning Media in the form of virtual laboratories.

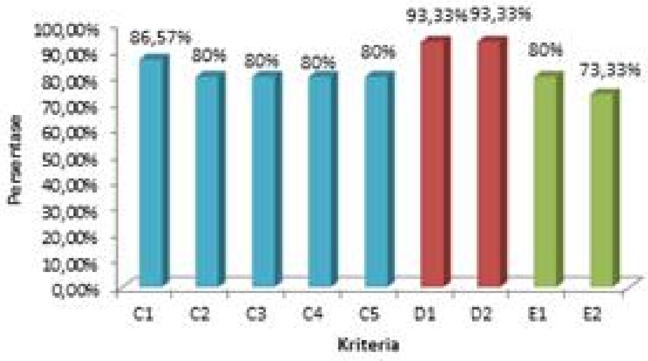

Fig.10 Construction Media Quality Validation Graph

Graph description of construct aspect validation:

C1: Presentation of material in the virtual laboratory is presented in the form of communicative illustrations.

C2: Presentation of material in the virtual laboratory is presented in attractive color combinations.

C3: Presentation of the material in the virtual laboratory presented with the use of color does not interfere with the material.

C4: There is student activity in the form of practice questions where students can activate their thinking skills in solving problems. (Virtual laboratory: "Problem Training")
a. Practice questions contained in virtual laboratories are made according to basic competencies and objectives.

C5: b. Practice questions on virtual laboratories are used to help students understand the inorganic chemistry of the main group elements.

E1: Accuracy of Indonesian language or use of spelling and grammar in accordance with EYD.

E2: The accuracy of the language used is in accordance with the age of the student.

Based on the chart above, to obtain the construct aspects personage ratings overall for the virtual laboratory of 82.96% while for *the e-Chem Edu* amounted to 81.11% . The percentage obtained is classified as a very valid criterion, namely where the very valid criteria have a range of 81-100% [17] . *Web* -based *blended learning* is a learning method used by combining *online* learning with classroom learning [18]. In the learning process, students generally use the cognitive realm in addition to their effective and psychomotor use through information gathering which is obtained briefly, but not much of the information obtained can be stored for a long time, especially in the depiction of macro, micro aspects. and symbolic, especially in the matter of inorganic chemistry, the main group elements . Its implementation in learning by using *blended learning* based virtual laboratories that is, by presenting a learning medium that can link all aspects of video, animation, text, and others. So that the appearance presented is more interesting and activities in the form of teaching and learning can be carried out in accordance with the learning objectives made. This can explain that learning to use virtual laboratories can facilitate learning. Besides that Virtual laboratories can be used to link the three levels of representation of chemistry so that they are effective in presenting complex and dynamic chemical concepts at the macroscopic, submicroscopic, and symbolic levels [19].

3) Instructional Quality

There are several aspects of instructional quality assessment that are validated.

a) Learning Media In The Form Of Virtual Laboratories

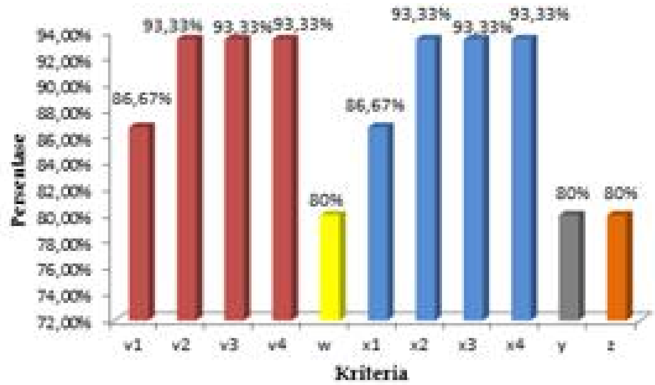

Fig.11 Instructional Media Quality Validation Graph

Graph description of instructional quality aspects validation:

v1 The use of *user control (next, previous, etc.) is* right, so that it can provide learning opportunities according to the speed of student learning
Virtual lab, *Scene* 1 *"Start"* button

v2 Virtual laboratory, *"home"* button

v3 Virtual laboratory, *"next"* button on "inorganic chemistry of the main group elements"

v4 Virtual laboratory, *"previous"* button on "understanding of inorganic chemistry of the main group elements"

W Operational instructions for using virtual laboratories based on *blended learning are* complete and clear

x1 The position and shape of the *user control are* consistent and have the same color and function on each *screen*
Virtual lab, *Scene* 1 *"Start"* button

x2 Virtual laboratory, *"home"* button

x3 Virtual laboratory, *"next"* button on "understanding of inorganic chemistry of the main group elements"

x4 Virtual laboratory, *"previous"* button on "understanding of inorganic chemistry of the main group elements"

Y Illustration quality in terms of laying, size, color and lighting

Z Design in a virtual laboratory makes it easy for students to learn material

Based on the results graph above, for the assessment of instructional quality aspects percentage overall gain for the virtual laboratory of 88.48% while for *the e-chem Edu* amounted to 81.67% Percentage obtained are classified into very valid criteria that is where very valid criteria ranges 81-100% value. So the *blended* *learning* based laboratory virtual is said to be very valid / feasible. According to Arsyad [20], on the overall instructional quality aspect that is assessed that is related to how the learning media developed can have an excessive impact on both students and teachers, can increase motivation and interaction, and be able to provide learning assistance and understanding for students. Further explained in the making of the learning design, the use of materials / instructional media provided by the teacher can be through *online* and conventional learning [21].

4) Technical Quality

There are several aspects in evaluating technical quality that are validated.

a) Learning Media in the form of Virtual laboratories

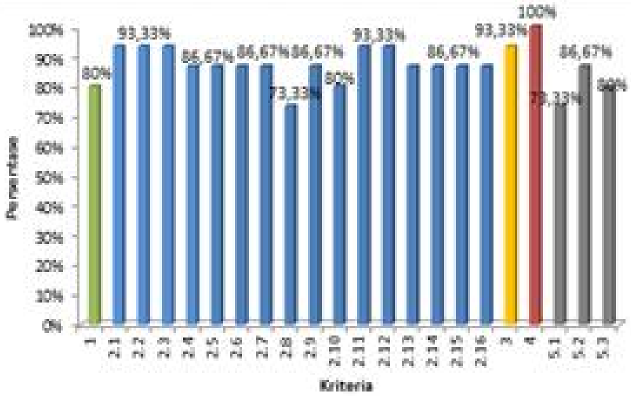

Fig.12 Media Technical Quality Validation Chart

Graph description of technical quality aspects validation:

1	Selection of model, size and color of text
2.1	Safety between text colors, *backgrounds,* and buttons Virtual lab, *Scene* 1 *"Start"* button
2.2	Virtual laboratory, *"home"* button
2.3	Virtual laboratory, *"next"* button on "understanding of inorganic chemistry of the main group elements"
2.4	Virtual laboratory, *"previous"* button on "understanding of inorganic chemistry of the main group elements"
2.5	Virtual laboratories: "Animation" Halogen button
2.6	Virtual laboratory: "Animation" Oxygen button
2.7	Virtual labs: "Animation" the Hydrogen button
2.8	Virtual laboratories: "Animation" Alkali button
2.9	Virtual laboratory: "Animation" Aluminum button
2.10	Virtual labs: "Learning Objectives" button
2.11	Virtual laboratories: The "Concept Map" button
2.12	Virtual laboratories: "Understanding" button
2.13	Virtual labs: "Properties" button
2.14	Virtual laboratory: Button "Animation
2.15	Virtual laboratory: "Practicum Video" button
2.16	Virtual laboratory: "Practice questions" button
3	Each part is well connected so that the virtual lab is clearly visible
4	Programs can be opened and closed easily
5.1	Accuracy of Indonesian language or use of spelling and grammar in accordance with EYD
5.2	The accuracy of the language used is in accordance with the age of the student
5.3	The words used are consistent

Based on the results of the graph above, for the assessment of technical quality aspects, the overall percentage for virtual laboratories is 87% while for *the e-chemistry website it is* 77.78% . The percentage obtained is classified into valid criteria , which is where the criteria has a range of 61-80% and is very valid, where the very valid criteria have a range of 81-100%. So the *blended learning* based laboratory virtual is said to be very valid / feasible. Assessment related to technical quality, namely legibility, ease of use, and quality of program management. The implementation is related to how the buttons on the virtual laboratory can function properly.

IV. CONCLUSION

The development of learning products in the form of interactive multimedia based on *blended learning* can be developed and declared valid / feasible as a medium in learning based on the quality of the content and objectives, instructional, technical, and construct to obtain the interpretation value of the average percentage score for instructional media in the form of interactive multimedia of 85 % while *the e-learning website* as a support for *blended learning* learning activities receives an overall percentage of 81% .

REFERENCES

[1] Walton, PH The Use Of Chemical Demonstrations In Lectures. The Royal Society Of Chemistry Journal, 2002, Vol. 61, pp. 22-27.

[2] Pekdağ, Bülent. 2, Alternative Methods in Learning Chemistry: Learning with Animation, Simulation, Video and Multimedia, Turkish Science Education, 2010, Vol. 7, pp. 111-118.

[3] Lasia, I.Ketut, Gunamantha, Budiada. 1, Training on the Use of Chemical Techniques to Improve Work Safety in the Chemical Laboratory (Pelatihan Teknik Penggunaan Bahan Kimia untuk Peningkatan Keselamatan Kerja di Laboratorium Kimia), WIDYA LAKSANA, 2017, Vol. 3, pp. 44-56.

[4] Dwiningsih, K., Sukarmin, Muchlis, and Rusli Hidayah.2, Inorganic Chemistry Learning Based on the Web Lite Course Molucca, Journal of Chemistry Education, 2015, Vol. V, pp. 22-30.

[5] Alexiou, Antonios, Christos Bouras, and Eleftheria Giannaka Virtual laboratories in the Education research Academic Computer Technology Institute, VirRAD European Project. 2004

[6] Tatli, Z. and Ayas, A. Virtual Laboratory Applications In Chemistry Education, Procedia Social and Behavioral Sciences, 2010, Vol. 9, pp. 938– 942.

[7] Klentien, Unchana, and Wannasade, Wannachai. Development of blended learning models with virtual science Laboratory for secondary students. Procedia-Social and Behavioral Science, 2006, 217, pp. 706-711.

[8] Tuysuz, Cengis. The Effect of the Virtual Laboratory on Students Achievement and Attitude in Chemistry. International. Journal of Education Scienses, 2010, Vol. 2, pp. 37-53.

[9] AP, Raffani Ovianti and Dwiningsih, Kusumawati. Developing Multimedia Interactive Based Blended Learning at Chemistry Subject Class XII. Surabaya: s.n, 2016. ISEL Seminar Proceedings.

[10] Rahma, Pipit Tri, and Dwiningsih, Kusumawati. Development of Student Worksheets Based Blended Learning in the Material of

Chemical Elements (Pengembangan Lembar Kerja Siswa Berbasis Blended Learning pada Materi Kimia Unsur). Unesa Journal of Chemical Education. 3 , Unesa Journal of Chemical of Education, 2017, Vol. 6, pp. 476-481.

[11] López-Pérez, M. Victoria., López-Pérez, M. Charmen., Rodríguez-Ariza, and Lazaro. Blended Learning in Higher Education: Students Perception and Relation to Outcom.Elsevier Journal, 2011, pp. 818-826.

[12] Hanson, David M.:. Instructor's Guided to Process Oriented Guided Inquiry Learning. Pacific Crest: Stony Brook University, 2006.

[13] Cole, RS and Bauer, CF Society: Assessing POGIL Implementations. In Process Oriented Guided Inquiry Learning (POGIL); American Chemical: Washington, DC, 2008, p. 213−225.

[14] Arham, Uliya Ulil and Dwiningsih, Kusumawati. 2, Feasibility of Interactive Multimedia Based on Blended Learning on the Chemical Elements Matter (Kelayakan Multimedia Interaktif Berbasis Blended Learning Pada Kimia Unsur), Unesa Journal of Chemical Education, Vol. 5, pp. 345-352.

[15] Damayanti, Dian, and Dwiningsih, Kusumawati.1, Development of Blended Learning Oriented Learning Devices in Class X High School Material of Elements Periodic System (Pengembangan Perangkat Pembelajaran Berorientasi Blended Learning pada Materi Sistem Periodik Unsur Kelas X SMA.). Unesa Journal of Chemical Education, 2016, Vol. 6, pp. 16-23, 2017.

[16] Wulandari, Diah Ayu, and Dwiningsih, Kusumawati. 3, Development of Learning Tools Based on Blended Learning in Colloid Materials (Pengembangan Alat Pembelajaran Berdasarkan *Blended Learning* pada Materi Koloid), Unesa Journal of Chemical Education, 2017, Vol. 6, pp. 446-451.

[17] Riduwan. Research Variables Measurement Scale (Skala Pengukuran Variabel-Variabel Penelitian). Bandung: Alfabeta, 2012.

[18] Dwiningsih, Kusumawati, Sukarmin, and Muchlis. The Effect of Self Regulated Learning on Student Cognitive Learning Outcomes Through Web-Based Blended Learning (Pengaruh Pembelajaran Self Regulated Learning Terhadap Hasil Belajar Kognitif Mahasiswa Melalui Blended Learning Berbasis Web). Surabaya: s.n, 2016. Proceedings of the National Seminar on PPM.

[19] Burke, KA, et al, Developing and Using Conceptual Computer Animations for Chemistry Instruction.12, Journal of Chemical Education, 1998, Vol. 75, pp. 1658-1661.

[20] Arsyad, Azhar. Instructional Media (Media Instruksional). Jakarta: Rajawali Press. 2013.

[21] Dwiningsih,Kusumawati, Sukarmin, and Muchlis Building the Design of Blended Learning in Web Lite-Based and Industrial Visits Inorganic Chemical Course, American Scientific Publishers, 2016.