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Development of Electrolyte Box to Improve Student Learning Outcomes at SMAN 2 Sungai Ambawang

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Abstract
The problems that arise in class X MIA SMA Negeri 2 Sungai Ambawang related to the learning process have not carried out practicum activities due to limited facilities and infrastructure at school. This study aims to develop Electrolyte Box media on electrolyte and nonelectrolyte solution materials that are valid, practical and effective. This type of research is Research and Development (R&D) ADDIE model. The sampling technique used is purposive sampling technique. The sample in this study amounted to 27 students of SMA Negeri 2 Sungai Ambawang. Validity is measured from the validator's assessment using the validation sheet, practicality is measured from the learner response questionnaire, then effectiveness is measured based on the pretest and posttest results of students. The data analysis technique is descriptive statistics. The results of the validity of the material and media aspects of the Electorlyte Box are 0.83 (very valid) and 0.79 (valid), respectively. The practicality test results in the initial and main field trials obtained very practical criteria with a value of 98.43% and 96.30% respectively. The effectiveness aspect in the initial and main field trials was 0.73 and 0.71 with high criteria. Therefore, the learning media in high school that has been developed is suitable for use as learning media.

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INTRODUCTION

Curriculum arrangement is carried out by the government to prepare education graduates in accordance with the real needs in the field. The curriculum implemented by the government at this time is the 2013 curriculum. One of the sciences studied in the 2013 curriculum is chemistry. Chemistry is one of the science learning groups whose learning process is to conduct experiments and research to find and discover various phenomena that occur in everyday life (Afliyani, et. al 2018).

One example of chemical phenomena in everyday life is the use of ORS in helping relieve stomach pain and isotonic drinks in helping replace body fluids lost during exercise. Both examples are phenomena related to chemistry material, namely electrolyte and non-electrolyte solutions. In addition, chemistry has an abstract nature that greatly affects students in mastering learning materials, this causes chemistry to have a high level of difficulty (Sabekti at, al., 2014). Chemistry subjects can be understood thoroughly if learning involves macroscopic, submicroscopic and symbolic concepts (Suari, Selamet, & Suja, 2018). One of the materials that includes these three concepts that must be built with understanding and depiction is the material of electrolyte and non-electrolyte solutions (Yuliana, Rudibyani, & Evkar, 2018).

Based on the results of interviews with one of the chemistry teachers at SMA Negeri 2 Sungai Ambawang, in the material of electrolyte and nonelectrolyte solutions there are still students who do not understand the material of electrolyte and nonelectrolyte solutions. This is because students are less motivated to learn on their own. In addition, practicum activities are also not carried out due to the lack of facilities and infrastructure owned by the school.

Limited learning media in learning activities is also one of the difficulties of teachers to deliver chemistry material, while the chemistry material that students must receive is so complicated (Prayoga, A.M. & Dewi, C.A, 2014). Practical activities were not carried out because the school did not have a labrotaorium and the practicum equipment was damaged by the floods that hit the school. So that students have never done practicum activities. The teacher only conducts learning activities using the lecture method using video media practicum of electrical conductivity test on the material of electrolyte and non-electrolyte solutions. So that students cannot be directly involved in learning.

Based on the results of interviews with six students of class X MIA 1 SMA Negeri 2 Sungai Ambawang, students revealed that chemistry lessons are difficult because they learn a lot of concepts and formulas and have never done practicum so that they are still constrained in understanding the material of electrolyte and non-electrolyte solutions. Whereas doing lab work can improve student learning outcomes. Because students gain learning experience directly in the field.

Basically, the subject matter in learning chemistry is electrolyte and nonelectrolyte material, students are required to be able to understand and distinguish electrolyte and nonelectrolyte solutions. Wangi, (2016) states that the understanding of concepts in electrolyte and nonelectrolyte solution materials includes: Understanding electrolytes and nonelectrolytes, Svante Arrhenius theory, electrolyte ion compounds and polar covalent compounds, strong and weak electrolytes. If students have difficulty in understanding this, then students will have difficulty in solving electrolyte and nonelectrolyte problems (Wangi, 2016).

Andromeda, (2016) stated that experimental activities can improve students' soft skills and hard skills because they aim to improve mastery of the material. Research conducted by Latifah, et al (2014) states that practicum activities in learning are needed to help students understand difficult concepts. The existence of practicum activities makes it easier for students to understand the concept of material and provides direct experience to students so as to create a meaningful learning (Zahro, 2016).

The intended experience is in the form of capital to use the scientific method in obtaining new knowledge and developing the knowledge that students already have through practical activities, because through practical activities students will be directly involved in the use of tools and materials, measurement, preparation or assembly of tools. In laboratory-based learning, learners are invited to be able to play an active role by developing the potential and abilities that exist in themselves.

In this problem, the lack of facilities and infrastructure as a medium to support practical activities and there are also other problems, namely practicum activities carried out by schools that are lacking in laboratory utilisation. The lack of utilisation of facilities such as the absence of tools for practicum in schools due to damage due to natural disasters such as floods, makes schools not carry out practicum. To assist students in carrying out practicum, a learning tool or media is needed that can support the chemistry learning process.

One of the learning media that can be used in electrolyte and non-electrolyte solution material is an electrolyte and non-electrolyte solution test kit. This electrolyte test kit is one of the alternative tools that teachers can use in conveying information or messages to students which can make it easier for students to receive the information conveyed. This is supported by Widayanti's research (2018) on the Development of Simple Practical Tools as Student Practicum Media, which resulted in the media having been successfully developed with a presentation of 86.7% criticized as very feasible. According to Susanti's research (2022) on the development of Chemical Equilibrium practicum tools for high school students in Pontianak, it resulted that the practicum tool media could improve learning outcomes with an N-Gain value of 0.8 in a very high category. According to Oktafiani's research (2017) on the Development of Multipurpose Optical Kit Props (AP-KOS) to Improve the Science Skills Process results in that the learning outcomes of students who use AP-KOS show a significant increase, this is indicated by the N-Gain value reaching 0.78 (high criteria).

In Umam's research (2017), electrolyte props were made. The media provides many benefits as a learning resource for electrolyte and non-electrolyte solutions. The absence of practicum tools in schools is one of the reasons practicum is rarely or even not done. Therefore, in this research, a practicum tool will be made on the material of electrolyte and nonelectrolyte solutions using materials that are around. This tool is made in the form of a box. The difference between this test tool and other test tools is that it is easy to carry everywhere and the circuit of the tool in the box so that during the practicum students only dip into the solution that has been provided. Electrolyte Box in this study is expected to be a learning media that can improve student learning outcomes and student motivation in learning.

METHOD

The research method used in this research is the research and development method (Research and Development) Sugiyono (2016). This method is used to produce a design and product (Dwitiyanti, 2020; Widayastuti, 2019; Rosmiati, 2020; Siregar, 2021). The research method used in this study refers to the ADDIE model which consists of stages, namely Analysis, Design, Development, Implementation and Evaluation. The ADDIE model was developed by Dick and Cary. Dick and Carry described the stages of the ADDIE model consisting of Analysis, Design, Development, Implementation, and Evaluation (Mulyatiningsih, 2012). The product developed in this study is the Electrolyte Box test tool on electrolyte and non-electrolyte solution materials. The development procedure can be seen in Figure 1.

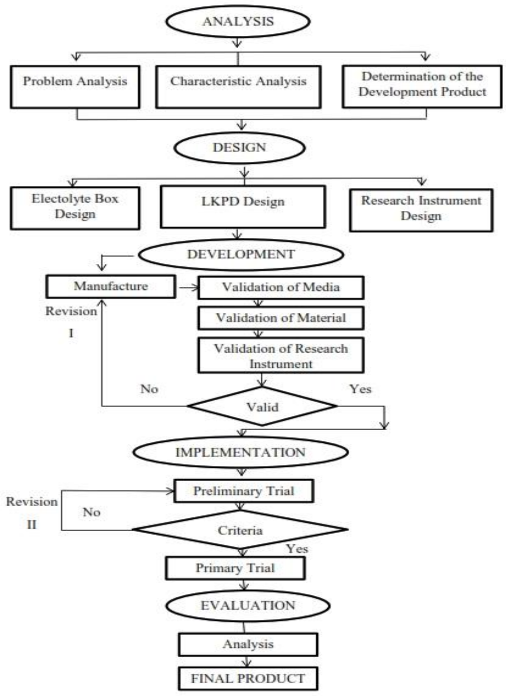


Figure 1. ADDIE research procedure

The analysis used in this research is problem analysis, analysis of student characteristics and analysis of the determination of products developed. Problem analysis was carried out by looking at journal references and teacher interviews. Analysis of student characteristics is obtained from teacher interviews regarding cognitive, affective and psychomotor students, as well as student interviews. While the analysis of the products developed is based on various kinds of media that have been developed.

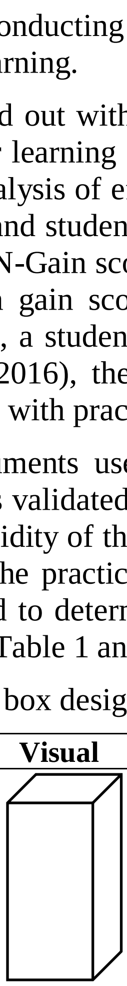
This research was conducted in class X MIA 2 in Sungai Ambawang including interviews with students and chemistry teachers who were interviewed directly at school. Validation is carried out on material and media experts and implementing practicum tools to students in class. The population in this study were students who studied chemistry, namely class X SMA Negeri 2 Sungai Ambawang, namely X MIA 1 and X MIA 2. The sample in this study was taken using purposive sampling technique. In the initial field trial, 6 students of class X MIA 1 SMA Negeri 2 Sungai Ambawang were taken with different levels of understanding. Of the six people, divided into 2 groups consisting of 3 students, each group has a different level of understanding, namely high, medium and low levels of understanding. In the initial field trial, before carrying out practicum activities, students worked on pretest questions. Furthermore, students carried out practicum activities using the Electrolyte Box tool to make observations of the solution that had been provided in each group. After conducting observation activities, students fill out posttest questions as an evaluation of the learning.

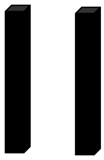
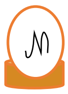
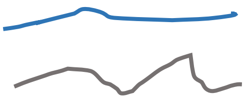
While the sample in the main field trial amounted to 27 students in class X MIA 2 SMA Negeri 2 Sungai Ambawang. In the main field trial, students were divided into 4 groups of 7 people per group. Due to the limitations of the tools made only 4 tools which resulted in each group totaling 7 people. In the initial field trial, before conducting practicum activities, students worked on pretest questions. Furthermore, students carry out practicum activities using the Electrolyte Box tool to make observations of the solution that has been provided in each group. After conducting observation activities, students fill out posttest questions as an evaluation of the learning.

Evaluation is carried out with formative assessment. Where formative assessment is carried out at the time after learning or during the learning process. The success criteria of the field trial, namely the analysis of effectiveness, used pretest and postest question sheets, increased learning outcomes and student understanding measured using pretest and postest results then analyzed using the N-Gain score (Bintiningtiyas, 2016). The media is said to be effective if it obtains a minimum gain score of 0.3 with moderate criteria (Bintingtiyas, 2016). In the practicality analysis, a student response questionnaire was used, based on the criteria stated by Bintiningtiyas (2016), the Electrolyte Box is said to be practical if the percentage of practicality is >61% with practical criteria.

The research instruments used were validation questionnaire and response questionnaire. Electrolyte Box was validated by media and material experts using a validation questionnaire to determine the validity of the media and material. The students' response questionnaire was used to determine the practicality of the developed media. Meanwhile, pretest and posttest questions were used to determine the effectiveness of learning using the media. Etectrolyte Box can be seen in Table 1 and Figure 2.

Table.1. Electrolyte box design

No	Visual		Description
1	Box		The box is made of clear colored acrylic material with size: - Length (11 cm) - Width (5.5 cm) - Height (3 cm)

		- Acrylic thickness (2 mm) - Electrode hole 4.5 mm - Distance between electrode holes 1 cm - Lamp holder hole diameter 1 cm The box serves as a place of unity of the test equipment materials
2	Battery 	The battery functions as a direct electric current generator. The battery power used is 9 Volts
3	Battery Rod (Electrode) 	The battery rod (carbon rod) functions as an electrode. Electrodes are electrical conductors that are connected to the electrolyte solution of an electric current circuit.
4	Lamp and lamp holder 	The lamp and lamp holder function as indicators that state electrolyte or nonelectrolyte solutions. The lamp used is a flashlight that has a power of 3.8 volts.
5	Cable 	The cable serves as an electric current connector from the battery to the electrodes (cathode and anode). The cable size from the lamp holder to the battery is 4 cm, the cable size from the battery to the electrode is 8 cm, and the cable size from the lamp holder to the electrode is 13 cm.

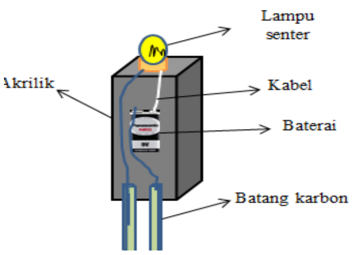


Figure 2. Electrolyte box design

The validation of Electrolyte Box was conducted in 2 stages. Stage 1 validation of Electrolyte Box and research instruments was conducted by 3 validators. Stage 2 Field trials conducted in 2 X MIA classes at SMA Negeri 2 Sungai Ambawang were measured from the validator's assessment using a validation sheet, practicality was measured from the students' response questionnaire and effectiveness was measured from the students' Pretest and Postest results.

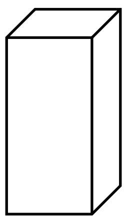
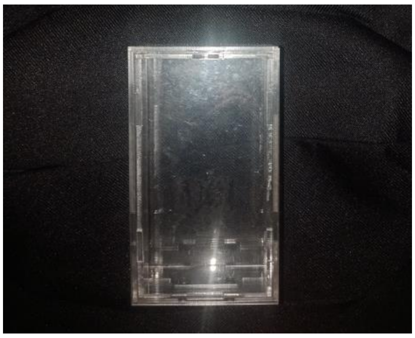
In addition to the Electolyte Box, in this study, LKPD was made. The purpose of the preparation of LKPD is to facilitate, facilitate and improve the results of the teaching and learning process in order to achieve the desired learning objectives. LKPD is connected with Electrolyte Box. At this stage the researcher designs the LKPD which is composed of LKPD cover, objectives, instructions, material description, learner activities and questions. The description of the LKPD design can be seen in Table 2.

Table 2. LKPD design

Page	Keterangan Desain	Link Desain
Page 1	The cover page consists of: - Title of the LKPD - Group identity - Material title - LKPD cover image	http://tinyurl.com/5zte79jc
Page 2	Page 2 consists of: - Student instructions - Purpose of the experiment - Material	http://tinyurl.com/5ew8y52d
Page 3	Page 3 consists of: - Material connection - Tool table	http://tinyurl.com/d7a4bxdt
Page 4	Page 4 consists of: - Materials table - Device circuit design - Experiment steps	http://tinyurl.com/43yrey3r
Page 5	Page 5 consists of: - Observation table - Conclusion form - Question.	http://tinyurl.com/2prxt63c
Page 6	Page 6 consists of: - Answer sheet.	http://tinyurl.com/366vh285
Page 7	Page 7 consists of: - Answer sheet	http://tinyurl.com/2ypmtxyr

The designed product is then made. All components in the design stage are assembled into one Electrolyte Box product which is made as attractive as possible so that students are happy and interested in participating in the learning process. The product can be seen in Table 3 and Figure 3.

Table 3. Electrolyte box product

No	Tool Name	Design	Product
1	Box		
2	Battery		

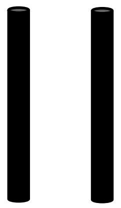
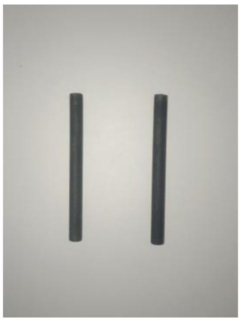
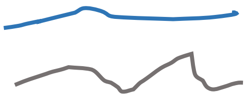
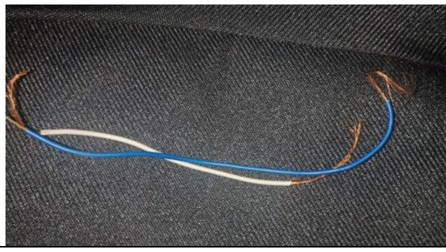
3	Battery Rod (Electrode)		
4	Lamp and lamp holder		
5	Cable		

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Figure 3. Electrolyte box product

RESULT AND DISCUSSION

Validity Analysis

The validity of Electrolyte Box depends on the validation analysis data. Validation analysis is used to determine whether or not the media developed is feasible (Eliza, 2019; Habibi, 2022; Fajriati, 2023; Almubarak, 2022). The results of the validity of the Electrolyte Box device are calculated based on the validation coefficient formulated in equation 1. With the validity criteria table seen in table 4.

Table 4. Aiken's validation coefficient

Assessment	Criteria
Very Less	1
Less	2
Good	3
Very good	4

$$V = \frac{\sum s}{n(c-1)} \qquad \text{(Equation 1)}$$

Description:
V = expert agreement index regarding item validation
S = R -Lo
Lo = lowest validation assessment number
C = highest validation assessment number
N = many experts/validators
R = the number given by the expert

Table 5. Criteria of validity

Assessment	Criteria
≤0,2	Invalid
0,2-0,4	Less Valid
0,4-0,8	Valid
≥0,8	Very Valid

Based on Retnawati (2016), this learning media is said to be valid if it reaches an assessment range of 0.39. The validation of Electrolyte Box was conducted by 3 validators, consisting of 2 lecturers of FKIP Muhammadiyah Pontianak and 1 chemistry teacher of SMA Negeri 2 Sungai Amabawang. Electrolyte Box validation data can be seen in Figure 4.

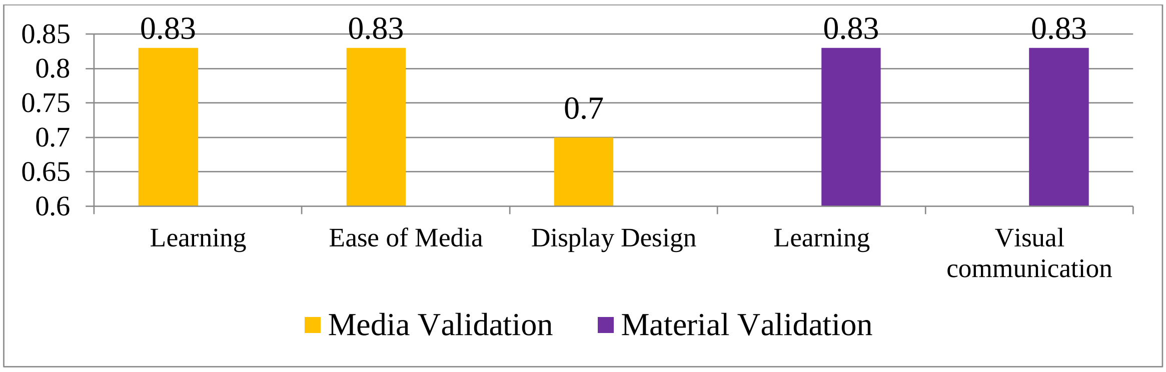

Figure 4. Graph of media and material validity of electrolyte box

The aspects in the media and material validation sheet each have 3 media aspects and 2 material aspects. Media aspects include learning aspects, media convenience aspects and display design aspects. While the material aspects include aspects of learning to the material and visual communication. Each aspect has sub-aspects, the learning aspect on the media has 6 sub-aspects, the media convenience aspect has 3 sub-aspects, and the display design aspect has 4 sub-aspects. While the learning aspect of the material has 6 sub-aspects and 2 sub-aspects of visual communication. The overall results of media and material validation of the media averaged 0.9 valid category for media validity and 0.83 very valid category for material validity.

Practicality Analysis

Practicality can be interpreted as the ease of use of the media developed (Marlini, 2019; Iswendi 2023; Kurniawati, 2022; Andromeda, 2018). Practicality analysis can be known based on the results of the analysis of the students' response questionnaire to the use of Electrolyte Box media. The response questionnaire statements include responses to the learning aspects, media aspects, and visual communication aspects of the Electrolyte Box media. Practicality results can be calculated using the scoring in Table 6 and calculated using equation 2 and matching the average percentage value of the students' response questionnaire with the percentage of questionnaire criteria in Table 7 (Bintiningtyas, 2016) which can be seen as follows.

Table 6. Learner response questionnaire answer options score

Answer Options	Criteria
Very Good (SB)	4
Good (B)	3
Less (K)	2
Very Less (SK)	1

Criteria score = Nmax X ΣP X ΣR

Description:
Nmax= highest score
ΣP= number of questions
ΣR= number of respondents.

$$\boldsymbol{P}(\%) = \frac{\textbf{Total Score}}{\textbf{Criteria Skor}}\, \boldsymbol{x}\ \mathbf{100\%} \qquad \textbf{(}\text{Equation 2)}$$

Table 7. Practicality criteria

Persentase	Kriteria
0%-20%	Impractical
21%-40%	Less Practical
41%- 60%	Quite Practical
61%-80%	Practical
81%-100%	Very Practical

Based on the criteria stated by Bintiningtyas (2016), the Electrolyte Box is said to be practical if the percentage of practicality is >61% with practical criteria. Practicality analysis can be known based on the results of the questionnaire analysis of students responses to the use of Electrolyte Box media. The results of the practicality analysis of the initial field trial and the main field trial can be seen in Figure 5.

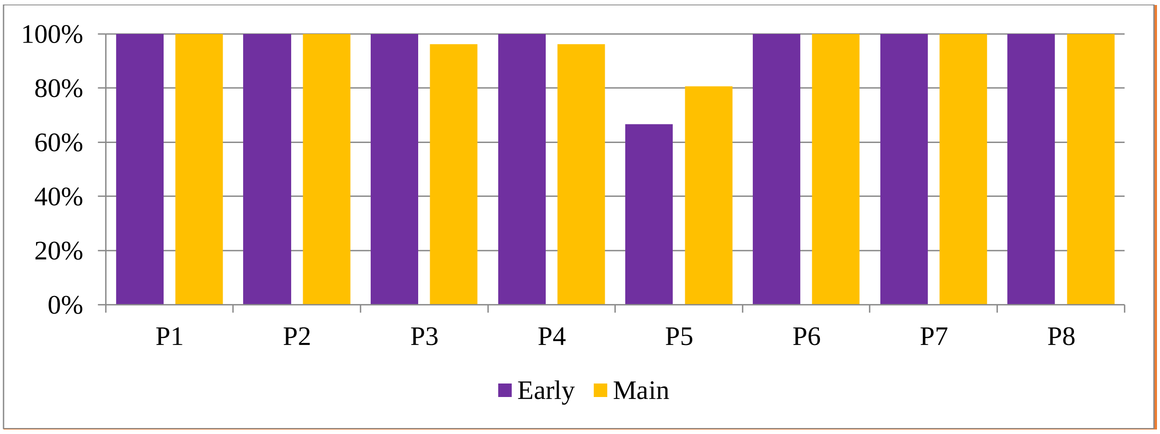

Figure 5. Practicality graph percentage of practicality of electrolyte box media

Description:
P1 (Electrolyte Box learning media can be used to understand the material)
P2 (The developed media can foster learning motivation)
P3 (Electrolyte Box learning media is fun to use in learning activities)
P4 (Electrolyte Box learning media is easy to use)
P5(Electrolyte Box media is easy to carry around)
P6 (After using Electrolyte Box media, learning is easier and does not cause boredom)
P7 (The appearance of the Electrolyte Box, makes me interested).
P8 (The writing used is easy to carry)

The results of the students response questionnaire, in general, students feel interested and understand the use of Electrolyte Box media. This can be seen based on the results of the recapitulation of the students' response questionnaire with a percentage of 95.83% and 96.30% for each indicator respectively in the initial field trial and the main field trial. The result of practicality is calculated by the percentage of the learners' response questionnaire based on the Likert scale calculation.

Effectiveness Analysis

Effectiveness analysis is used to test media developed whether it can improve student learning outcomes or not improve student learning outcomes. The media developed can be said to be effective, if the results of statistical analysis improvement learning outcomes and the level of understanding of student material provide a significant difference in student learning outcomes between before using the media and after using the media. significant difference in student learning outcomes between before using the media and after using the media (Purba, 2020; Fatimah, 2021; Putri, 2019; Inayah, 2021). The improvement in learning outcomes and student understanding is measured using pretest and postest results and then analyzed using the N-Gain score (Bintiningtiyas, 2016). The criteria table of the N-gain formula can be seen in Table 8 and Equation 3.

Table 8. Criteria of the N-gain formula

N-Gain Score	Improvement Criteria
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

$$g = \frac{(S\,postest - S\,pretest)}{(S\max - S\,pretest)} \quad \text{(Equation 3.)}$$

Description:
Spretest = average score of pretest
Spostest = average score of posttest
g= the magnitude of the line factor

The media is said to be effective if it obtains a gain score of at least 0.3 with moderate criteria (Itiqomah, 2021; Trimayanto, 2019; Hidayah, 2021; Pikoli, 2021). The effectiveness analysis was carried out by giving pretest and posttest questions to students. The pretest and posttest questions used in the initial field trial and main field trial must be validated first by validators before being used in the trial. The use of Electrolyte Box media to improve students' understanding of electrolyte and non-electrolyte solution materials assessed using the N-Gain formula can be seen in Table 9.

Table 9. Recapitulation of students learning outcomes

Field Test	Number of Students	Average		N-Gain
		Pretest	Posttest	
Early	6 Students	30,38	81,5	0,73
Main	27 Students	23,24	78,37	0,71

Table 9. shows that there was an increase in scores between before and after using Electrolyte Box media in the initial field trial and main field trial of 51.12 and 55.13, respectively. Based on Bintiningtyas (2016), the effectiveness obtained is in the high category. The pretest and posttest scores that state the effectiveness of Electrolyte Box media can be seen in Figure 6.

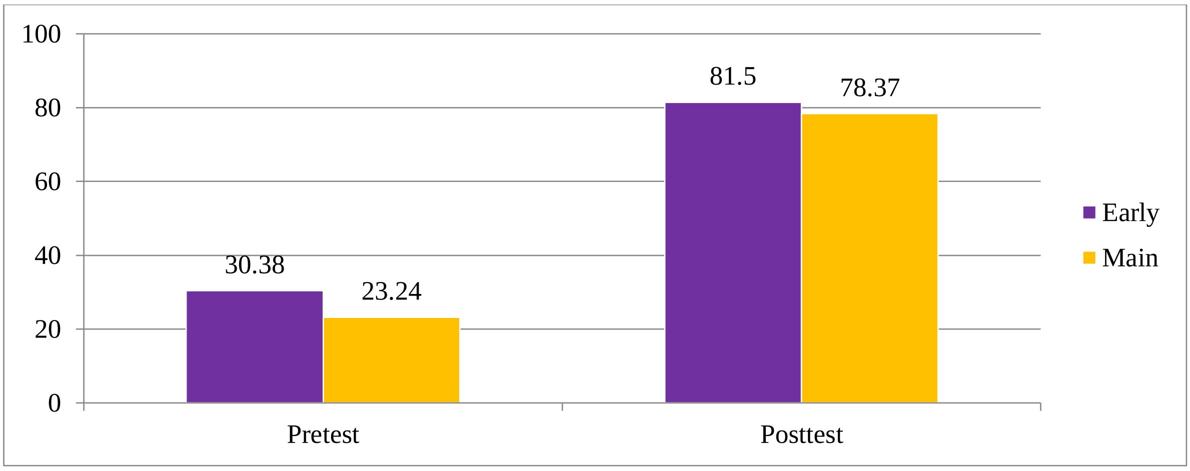

Figure 6. Graph of recapitulation of pretest and posttest values

Figure 6. shows a decrease in pretest and posttest scores in the initial field trial and main field trial. The decrease in pretest scores was 7.14 while the decrease in posttest scores was 3.13, this was due to more main field trial students than the initial field trial so that it made classroom conditions less conducive. The results of the initial field trial and the main field trial decreased the N-Gain value by 0.02. The decrease in N-Gain was also due to the posttest results in the main field trial showing 9 out of 27 learners had not reached the completeness value. Most students were mistaken because these two questions were almost the same, namely the characteristics of nonelectrolyte solutions (question number 2) and examples of nonelectrolyte solutions in everyday life (question number 4). The average N-Gain values in the initial field trial and main field trial were 81.5 and 78.37 respectively with high criteria. The effectiveness and high N-Gain scores are thought to be the influence of assistance from the use of Electrolyte Box media that makes it easier for students to understand electrolyte and nonelectrolyte solution materials.

CONCLUSION

Electrolyte Box media developed in this study has been feasible to use as learning media on electrolyte and non-electrolyte solution materials. The results of the validity of the material aspects and media aspects were 0.79 with valid criteria and 0.83 with very valid criteria. The percentage of practicality based on the distribution of response questionnaires in the initial field trial and the main field trial was 95.83% and 96.30% respectively with very practical criteria. The effectiveness based on the analysis of learning outcomes after using Electrolyte Box media with the Gain score in the initial field trial and main field trial was 0.73 and 0.71 with high criteria, respectively.

RECOMMENDATION

It is important to distribute the media to different Schools with a larger number of subjects. For the use of Electrolyte Box, care must be taken to ensure the completeness of the media. Before use, make sure the equipment or composition of the media is functioning properly.

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BIBLIOGRAPHY

Afliyani, Reni. Ismono. (2018). Penerapan Model Pembelajaran Guide Inquiry Untuk Melatih Keterampilan Proses Sains Siswa Pada Materi Asam Basa. *Unesa Journal of Chemical Education*. 7(2): 194-199.

Almubarak & Saadi, P. (2022). Validity, Practicallity, Effectiveness: Wetland Contexted Chemical Representation Module as a Media for Learning. *Journal of Mathematics, Science, and Computer Education.* 2(1), 56-72.

Arsyad, A. (2014). *Media Pembelajaran*. Jakarta: PT. Raja Grafindo Persada.

Andromeda, A., Bahrizal, B., & Ardian, Z. (2016). Efektifitas Kegiatan Praktikum dalam Pembelajaran pada Materi Kesetimbangan Kimia Kelas XI SMA/MA. *ESAKTA*, 1, 45-51.

Andromeda, A. et al. (2018). Validity and Practicality of Experiment Integrated Guide Inquiry-Based Module on Topic of Colloidal Chemistry for Senior High School Learning. *IOP Conference Series: Materials Science and Engineering.* **335** 012099.

Annurahman. 2009. Belajar dan Pembelajaran. Bandung: Alfabeta

Astuti, I. A. D., Sumarni, R. A., & Saraswati, D. L. (2017). Pengembangan Media Pembelajaran Fisika Mobile Learning Berbasis Android. JPPPF- *Jurnal Penelitian dan Pengembangan Pendidikan Fisika*, 3(1), 57-56.

Britiningtiyas, N. & Lutfi, A. (2016). Pengembangan Permainan Varmintz Chemistry Sebagai Media Pembelajaran Pada Materi Sistem Periodik Unsur (*Development of Varmintz Chemistry as Learning Media on Periodic System of Element)*. *Jurnal Mahasiswa Teknologi Pendidikan.* 5(2): 302-308.

Dwitiyanti, N., Kumala, Ayu S., Widiyatun, F. (2020). Using the ADDIE Model in the Develoment of Physics Unit Conversion Application Based on Android as Learning Media. *Formatif: Jurnal Ilmiah Pendidikan MIPA.* 10(2), 125-132.

Eliza, F. et al. (2019). Validity of Android-Based Learning Media in Subject Measurement and Instrumentation. *Journal of Physics: Conference Series.* **1387** 0122028

Fajriati, D. W. & Putra, A. (2023). Validity and Pracicality of Animated Video-Based Learning Media on Various Force and Inetial Object Materials. *Physics Learning and Education.* 1(3), 127-145.

Fatimah, N. & Hidayah, R. (2021) The Development of CIHOE Game as a Learning Media in the Elemental Chemistry Material. *International Journal of Active Learning.* 6(2), 49-57

Habibi, A. R. & Agustini, R. (2022). Validity of Learning in Reaction Rate Matter. *Journal of Chemistry Education Research.* 6(1), 8-13.

Hamzah, B, U. & Nina, L. (2011). *Teknologi Komunikasi dan Informasi Pembelajaran.* Jakarta: PT. Bumi Aksara.

Hayati, S., Budi, A. S., & Handoko, E. (2015). Pengembangan media pembelajaran flipbook fisika untuk meningkatkan hasil belajar peserta didik. In *Prosiding Seminar Nasional Fisika (E-Journal)*(Vol. 4, pp. SNF2015-II).

Hidayah, R. et al. (2021). The Effectiveness of Computer-Based Games AS a Learning Media on THE IUPAC Name of Inorganic Compounds. *J-PEK: Jurnal Pembelajaran Kimia.* 6(2), 100-108

Inayah, N. & Masruroh. (2020). PhET Simulation Effectiveness as Laboratory Practices Learning Media to Improve Students' Concept Understanding. *Prima Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Kimia Matematika dan IPA IKIP Mataram.* 9(2),152-162

Istiqomah, et al. (2021). Development of Learning Media for Formalin Test Teaching Aids to Increase Interest In Learning and Chemical Literacy of SMK Students. *Journal of Science Education and Practice.* 1 (2), 74-82.

Iswendi & Husni, H. I. (2023). Practicality and Effectiveness of Chemical Ludo Games as Learning Media of Acid and Base Materials to Student of Class XI SMA/MA. *Journal of Educational Sciences.* 7(2), 334-340.

Junaidi, E., Hakim, A., Hadisaputra, S., & Savalas, L. R. T. (2020). Upaya Meningkatkan Motivasi Siswa SMA Masuk Program Studi Pendidikan Kimia FKIP UNRAM Melalui Pengenalan Praktikum Kimia Sederhana di SMAN 1 Pringgarata. *Jurnal Pengabdian Masyarakat Sains Indonesia*, *2*(1).

Kustandi, C., & Sutjipto, B. (2011) *Media Pembelajaran Manual dan Digital*. Bogor: Ghalia Indonesia

Kurniawati, E. & Aini, S. (2022) Validity and Practicality of Guided Inquiry-Based Interactive Multimedia on Topic of Acid-Based for Senior High School Learning. *Jurnal Penelitian Pendidikan IPA.* 8(40), 1985-1991

Latifah. S., S. Sugiharto & Saputro, A. N. C. (2014). Studi Komparasi Penggunaan Praktikum dan Demonstrasi pada Metode Problem Solving Terhadap Prestasi Belajar Siswa Materi Hidrolisis Garam Kelas XI Ilmu Alam SMA Al Islam 1 Surakarta Tahun Pelajaran 2010/2011. *Jurnal Pendidikan Kimia.* 3(3): 111-120.

Marlini, C. (2019). Practicality of the Use of Media Learning Reading Beginings Based on Macromedia Flash. *Journal of Nation,* 692), 277-289.

Maswan, & Muslimin, K. (2017). Teknologi Pendidikan: Penerapan Pembelajaran Yang Sistematis. Pustaka Pelajar.

Mawarni, E., Mulyani, B. & Yamtinah, S. (2015). Penerapan Peer Tutoring Dilengkapi Animasi Macromedia Flash dan Handout untuk Meningkatkan Motivasi Berprestasi dan Prestasi Belajar Peserta Didik Kelas XI IPA 4 SMAN 6 Surakarta Tahun Pelajaran 2013/2014 pada Materi Kelarutan dan Hasil Kali Kelarutan. *Jurnal Pendidikan Kimia* (JPK), 4(1):29-37.

Mulyatiningsih, E. (2012). *Metode Penelitian Terapan Bidang Pendidikan*: Bandung: Penerbit Alfabeta.

Oktafiani, Putri., Subali, Bambang., & Edie, Suskiwo Supeni. (2017). Pengembangan Alat Peraga Kit Optik Serba Guna (AP-KOS) Untuk Meningkatkan Keterampilan Proses Sains. *Jurnal Inovasi Pendidikan IPA.* 3(2).

Pikoli, M. & Lukum A. (2021). Development of Audio-Visual Learning Media Integrating Character education in Chemistry Learning to Facilitate Conceptual Change and Character Strengthening of High School Students. *Journal of Physics: Conf. Ser.* **1968** 012007.

Prayoga, A.M., & Dewi, C.A. (2014). Pengembangan Bahan Ajar Reaksi Redoks dan Elektrokimia Berbasis Problem Posing. *Hydrogen: Jurnal Kependidikan Kimia*, 2(2), 178-191.

Purba, L. S. L. (2020). The Effectiveness of the Quizizz Interactive Quiz Media as an Online Learning Evaluation of Physics Chemistry 1 to Improve Student Learning Outcomes *Journal of Physics: Conf. Ser.* **1567** 022039.

Putri, S. A. & Aznam, N. (2019). The Effectiveness of Science Learning Media Using Focusly Software on Junior High School Students' Higher Order Thinking Skills. *Scientie Educatia: Jurnal Pendidikan Sains.* 8(1), 12-22.

Retnawati, H. (2016). *Validitas Reliabitas dan Karakteristik Butir (Panduan Untuk Peneliti, Mahasiswa dan Psikomotorian)*. Yogyakarta: Parama Publshing

Rosmiati, U. & Siregar, N. (2021).Promoting Prezi-PowerPoint Presentation in Mathematics Learning: the Development of Interactive Multimedia by Using ADDIE Model. *Journal of Physics: Conference Series.* **1957** 012007

Rusman, D., & Pd, M. (2012). *Model-Model Pembelajaran.* Jakarta:Raja Grafindo.

Sabekti, A.W. , Widarti, H. R. (2014). Analisis Pemahaman Konsep Siswa Kelas XI IPA SMAN 1 Malang Pada Topik Bentuk Molekul . Jurnal Zarah, 2(1), htpps://doi.org/10.24036/jep.vli2.48.

Sari, I., Wijayanti, I. E., & Nidaurrohman, N. (2018). Kualitas Bonbon Bond Sebagai Media Pembelajaran Pada Topik Ikatan Kimia [The Quality of Of Bonbon Bond Aa A Learning Media On Chemical Bonding Topics]. *A Journal of Language, Literature, Culture, and Education,* 14 No. 2, 199-208

Siregar, S., Sitompul, H., Wijaya, K., & Perangin-angin.,S. (2021). Development of "Concrete Work Practice" Learning Media by Using the ADDIE Model. *Atlantis Press: Advances in Social Sciens, Education And Humanities Research. Vol. 591*

Suari, J. N., Selamet, I., & Suja I. (2018). Profil Model Mental Siswa Tentang Larutan Elektrolit dan Nonelektrolit. *Jurnal Kependidikan Kimia Indonesia,* 2(2),59-53

Sugiyono. (2016). Metode Penelitian Pendidikan; Pendekatan Kuantitatif, Kualitatif dan R &. Alfabeta Bandung.

Sunyono, Wirya, I.W., Suyadi,G., dan Suyanto,. E., (2009). Pengembangan Model Pembelajaran Kimia Berorientasi Keterampilan Generic Sains pada Siswa SMA di Provinsi Lampung. Laporan Penelitian Hibah Bersaing Tahun I dikti, Jakarta.

Susanti, Leni., Fadhilah, Raudhatul., & Kurniati, Tuti. (2022). Pengembangan Alat Praktikum Kesetimbangan Kimia Untuk Siswa SMA di Pontianak. *Hydrogen: Jurnal Kependidikan Kimia.* 10(2).

Trimayanto, S. & Novita, D. (2019). The Effectiveness of Practicum KIT AS a Learning Media to Train Science Process Skills (SPS). *Journal of Chemistry Education Research.* 3(2), 34-41.

Ulya, H., Rudibyani, R. B., & Efkar, T. (2017). Pengembangan Modul Kimia Berbasis Problem Solving Pada Materi Asam Basa Arrchenius. *Jurnal Pendidikan dan Pembelajaran Kimia,* 7(1), 129-141.

Umam, M. Khotibul. (2017). *Pengembangan Alat Peraga Pendekteksi Banjir Sebagai Sumber Belajar Materi Larutan Elektrolit dan Nonelektrolit Untuk SMA/MA Kelas X.* Yogyakarta: Program Studi Pendidikan Kimia Universitas Islam Negeri Sunan Kalijaga.

Wangi, Lalu Lian Hari. (2013). Proses Penerapan Model Pembelajaran STAD Dengan Media Alat Peraga dan Media *Flash* Terhadap Pemahaman Konsep Larutan Elektrolit dan

Nonelektrolit Siswa Kelas X MAN Gerung. *Hydrogen: Jurnal Kependidikan Kimia.* 1(1).

Widayanti, W., & Yuberti, Y. (2018). Pengembangan Alat Praktikum Sederhana Sebagai Media Praktikum Mahasiswa. *JIPFRI (Jurnal Inovasi Pendidikan Fisika Dan Riset Ilmiah)*, *2*(1), 21-27.

Widayastuti, E. & Susiana (2019). Using the ADDIE model to Develop Learning Material for Actuarial Mathematics. *Journal of Physics: Conference Series.Ser.* ***1188*** *012052*

Yuliana, D., Rudibyani, B.R., & Evkar, T. (2018). *Efektifitas LKS Berbasis Multipel Representasi Dalam Meningkatkan Penguasaan Konsep Materi Larutan Elektrolit dan Non Elektrolit*. Universitas Lampung.

Zahro, A. (2016). Pengembangan Lembar Kerja Siswa Berbasis Praktikum Dengan Model Inkuiri Terbimbing. *Jurnal Biologi dan Pembelajaran Biologi.* 1(1): 1-9.