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Development of electronic activity sheet based preview, question, read, reflect, recite, review (pq4r) learning strategy on ion balance and pH of buffer solution

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ABSTRACT

The development of a PQ4R-based electronic activity sheet on the material of ion balance and pH of the buffer solution aims to develop a valid electronic activity sheet and determine user responses in learning. The research method used is the research and development (R&D) method by applying a 4-D development model which includes Define, Design, Develop and Disseminate. Pandemic conditions cause research to only be carried out until the Develop stage which was followed by one-on-one trials, teacher trials, and limited trials. The data collection tools used were validity sheets and user response questionnaires. The data analysis technique used is to calculate the results of the validation percentage score and user response. The results of the study explain that the PQ4R-based electronic activity sheet developed has been categorized as "valid" according to 2 material validation experts and 2 media validation experts based on the feasibility of content, PQ4R characteristics, language, presentation, display, and software utilization with average scores are 100%, 96.42%, 97.5%, 87.5%, 99%, and 98.21%. One-on-one trials were carried out on 3 students with different abilities to get comments that were used as improvements to the electronic activity sheet. The results of the user response test for 3 teachers and 20 students were categorized as "very good" with scores of 92.59% and 84.87%, respectively.

1. Introduction

In early 2020 President Jokowi announced the first positive case of Covid-19 in Indonesia. Positive cases of Covid-19 in Indonesia have skyrocketed since the first case was announced (Ansori, 2020). All access to the Government sector in Indonesia has been hampered due to the Covid-19 Pandemic, especially Education, thus making Mr. Nadiem Makarim as Minister of Education and Culture issue an online learning letter to prevent the chain of transmission of the Covid-19 virus. Students and teachers are required to use digital media with internet access to allow the process of online learning interaction to occur, in this case, the teacher must also be able to provide teaching materials for students through digital tools so that they can access them from home (United Nations, 2020). Selvaraj et al. (2021) mentioned there is a need for more investment in technology and basic

infrastructure which will ensure uninhibited access to online classes for students and teachers belonging to all strata of society (Silaen & Silaban, 2022; Sinaga et al. 2022).

The chemistry material in class 11th grade Senior High School is ion balance and pH of a buffer solution, this material is not only in the form of theory and calculations but also experiments so that it requires analysis and a clear understanding of the concept. Based on the information obtained, students still find it difficult to understand the buffer solution material because the material is very complex involving concepts, calculations, and experiments. Students also said that the material for ion balance and pH of buffer solutions and salt hydrolysis have the same similarities because they involve acid and base reactions so students find it difficult to distinguish the use of the pH calculation formula for the given problem.

The student activity sheet is generally known as print-based teaching materials, but in industrial revolution 4.0, they can be presented in an interactive IT-based form. This is in line with what Yusuf et al. (2015) said that 21st-century students are required to apply technological tools for everyday life in developing the skills learning process, thus electronic activity sheets are suitable teaching materials implemented by the demands of 21st-century learning and online learning that relies heavily on the internet. Lohr et al. (2021) explained the interplay of teachers and students become important in the effective use of technology for teaching and learning in order to promote students' knowledge and skills.

The teachers at Cendana Senior High School and Senior High School 1 in Pekanbaru informed that the existing student activity sheet was still in printed form, but due to online learning, the printed student activity sheet used was a soft file student activity sheet which was saved on word or pdf format. The student activity sheet is distributed to students through a learning platform to work on, then students are also given the freedom to use their gadgets and laptops to support the smooth learning process. The problem is when using printed worksheets in the form of soft files, students write their answers on another answer sheet and send them back to the learning platform, this is of course not efficient both in time and effort.

According to Asrori (2013), the basic components of a learning program must include a learning strategy consisting of a series of activities that can lead to mastery of concepts. PQ4R is a strategy that requires students to be active in finding concepts and understanding the substance of reading texts using their way of thinking (Hendi, 2017). Setiawati & Corebima (2018) mentioned PQ4R strategy is easy to be applied at all levels of education, and it is able to assist students improve their questioning skills and communicating their knowledge. The use of the PQ4R strategy is expected to help students to understand reading materials and to make the course more meaningful (Sartika & Hadi, 2021). Therefore, with the combination of PQ4R learning strategy and electronic activity sheets teaching materials, it is hoped that they can guide students in understanding very complex buffer solution materials, especially in the online learning process.

The objectives of this research are first, to develop a valid electronic activity sheet on material of ion balance and pH of the buffer solution based on the feasibility of content, PQ4R characteristics, language, presentation, display, and software utilization. Second, to determine the user responses in the learning process.

2. Method

The research was carried out at the Chemistry Faculty of Riau University, Senior High School 1, and Cendana Senior High School in Pekanbaru. The research time was spent 7 months starting from January to August 2021. The research method used was the research and development (R&D) method by applying a 4-D development model consisting of Define, Design, Develop and Disseminate. The reason for choosing the 4-D development model is it does not need to take a very long time to

develop the product because the stages of 4-D are not complex. However, due to pandemic conditions and time constraints, the research was only carried out up to the Development stage. The following is the 4-D development flow by Triyanto (2012) which was modified by the researcher in Figure 1.

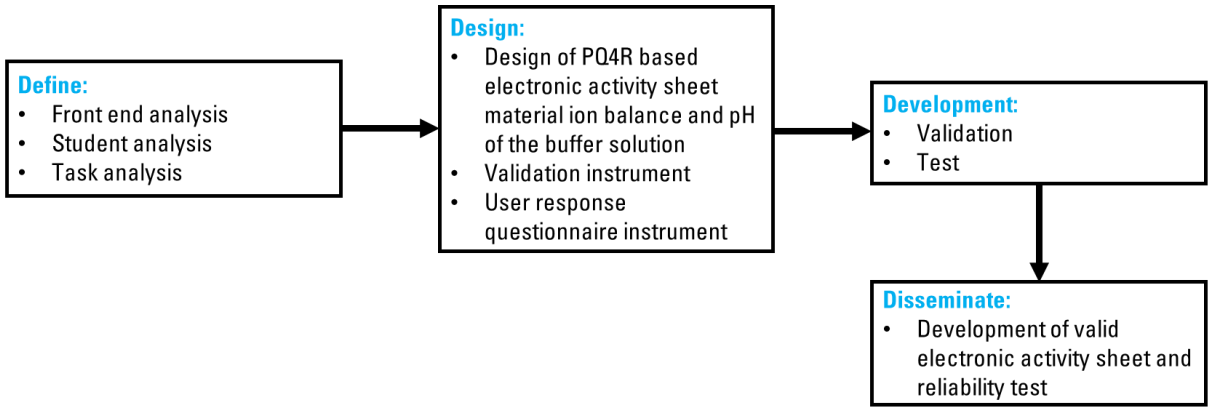

Figure 1. Development Flow of PQ4R-Based Electronic Activity Sheet Material Ion Balance and pH of the Buffer Solution with a modified 4-D model.

The trial subjects consisted of 3 students with different abilities in the one-on-one trial, 3 chemistry teachers in the teacher trial, and 20 students in the limited trial. The data collection tool used is a validity sheet to determine the validity category of the PQ4R-based electronic activity sheet and a user response questionnaire to determine the user response category to the PQ4R-based electronic activity sheet.

Table 1. Validity Category (Rohmad et al. 2012)

Percentage	Category
75.00-100	Valid
50.00-74.99	Quite Valid
25.00-49.99	Not Valid
0.00-24.99	Invalid

Table 2. User Responses (Sari et al. 2016)

Persentase	Category
75.00-100	Very Good
50.00-74.99	Good
25.00-49.99	Low
0.00-24.99	Not Good

The data analysis technique was carried out by analyzing the electronic activity sheet, validity sheet and user response questionnaires in the form of Likert scale data 1-4. The validity of the electronic activity sheet is obtained by calculating the % score of each feasibility assessment on the validity sheet in Table 1. After the electronic activity sheet is declared valid according to 2 material and media validation experts, the electronic activity sheet can be tested one-on-one on 3 students with different abilities so that comments are obtained that are used to eliminate errors in the electronic activity sheet. The electronic activity sheet can be continued into teacher trials and limited trials to determine user responses, the user responses category in Table 2.

3. Results and Discussion

The product resulting from the research is an electronic activity sheet with the stages of completing the PQ4R strategy task on the ion balance material and the pH of the buffer solution. The following are the results and discussion of the 4-D development model.

3.1. Define of Electronic Activity Sheet

This stage consists of 3 steps which include, front end analysis, student analysis, and procedural analysis. At the front end of analysis, information related to teaching materials and facilities used by the teacher was obtained in the matter of ion balance and the pH of the buffer solution. The teaching materials used by teachers are in the form of printed teaching materials, namely student activity sheet, but the student activity sheet used is still in a general form which includes questions and materials, so that there are no model steps or learning strategy that can help students understand the concept. According to Ramdoniati et al. (2019), the success of the learning process is determined by the teacher's ability to use and develop teaching materials. Teaching materials must also include learning strategies that can arrange student activities in understanding a learning concept, such as ion balance material and pH of buffer solutions. One of the learning strategies that can be used is the PQ4R learning strategy which requires the activeness of students to find concepts and understand the substance of reading texts using their way of thinking (Hendi, 2017). The facilities and infrastructure are adequate with the availability of a chemistry laboratory at the school which is used for the implementation of practical work on ion balance material and the pH of a buffer solution, but due to online learning, the chemistry laboratory cannot be used in the learning process. According to Ramlawati et al. (2014), an electronic activity sheet displays information in a structured, interesting, interactive way, and can be used anytime and anywhere. The electronic activity sheet can be designed as attractive as possible by adding experimental simulation videos that can be used as an alternative solution in online learning, where students are not allowed to use school facilities and infrastructure, namely the chemistry laboratory. This is also by what Izzania & Widhihastuti (2020) said that the use of experimental video in online learning during the Covid-19 pandemic is very feasible, because it can train science practicum skills. Based on the syllabus of the Indonesian Ministry of Education and Culture, the sub-chapter of ion balance material and pH of buffer solutions that use experiment is to distinguish the pH of buffer solutions and non-buffer solutions and make buffer solutions with a certain pH, therefore with the presence of electronic activity sheet, these experiments can be converted into experimental video as the content of the electronic activity sheets. There are several software that can be used to design electronic activity sheet such as 3D Page Flip which has been developed by Yusnelti & Asrial (2019) and Kvisoft Flipbook which has been developed by Ikhwani & Kuntjoro (2021). The two electronic activity sheets are designed and released in html5 format, but accessing these two electronic activity sheets, require html5 reader applications such as Adobe Flash, where Adobe Flash has stopped since December 30, 2020, so access to Adobe Flash cannot be used. In contrast to these two software, the web sway office can design electronic activity sheets teaching material without using an html5 reader application supporter, this is because the output from the web sway office is in a web format that can be directly accessed by users via smartphones or laptops. The web sway office can also take main sources from various sources, for example taking youtube videos, tweets, and other web components based on frame content such as google forms (Sudarmoyo, 2018; Silaban, 2021).

In the analysis of students, it was found that in the learning process students were more likely to look for chemistry learning references through their gadgets and laptops than books. Based on research conducted by the Global Educations Census (2018), Indonesian students globally are ranked highest in using IT spaces in schools. Indonesian students also occupy the second highest position in the world in using computers, not only that as many as 67% of Indonesian students use gadgets when studying at school and 81% use them to study at home. Anshari et al. (2017) said gadget becomes a tool that makes students productive as long as directed by proper usage rules. The presence of an electronic activity sheet will be right on target because they are by the characteristics possessed by students. The information obtained by students is still difficult to understand the buffer solution

material because the material is very complex involving concepts, calculations, and experiments. Students also said that the material for ion balance and pH of buffer solutions and salt hydrolysis have the same similarities because they involve acid and base reactions so students find it difficult to distinguish the use of the pH calculation formula for the given problem. This condition is in line with what Sanjiwani et al. (2018) said that the buffer solution material binds to several other chemistry concepts. If students do not understand basic chemistry concepts such as chemistry equations and acid-base solutions, then students will find it difficult to understand intricate and complex chemistry concepts. Students are also more likely to have discussions with friends in solving a chemistry problem, in this case, it means that students are accustomed to conducting group discussions to solve a chemistry problem so that they understand a concept. According to Ratih & Rohaeti (2020) efforts to improve students' understanding of chemistry concepts, educators can make variations on the learning strategy carried out. The selection of learning strategies must also be by the way of learning that has been done by students, in this case, students tend to have group discussions so that the appropriate learning strategy used is a strategy that utilizes group collaboration to find a chemistry concept. The learning strategy that can be used is the PQ4R learning strategy which requires students to play an active role in finding concepts with their way of thinking (Hendi, 2017). So with the combination of the PQ4R learning strategy and electronic activity sheet web-based teaching materials, it is hoped that students will find it easier to understand the concept of ion balance material and the pH of a buffer solution.

Task analysis includes analysis of the structure of the content, concepts, procedural, and objectives. The content structure analysis was carried out to analyze the ionic balance material and the pH of the buffer solution based on core competence and basic competence which refers to the latest revised 2013 curriculum syllabus, so that the material for ion balance and pH of the buffer solution is obtained in several sub-topics, including, the nature of the buffer solution, the pH of the buffer solution, and the role of the buffer solution. In the concept analysis stage, sub-topics were found on the material of ion balance and the pH of the buffer solution which will be arranged systematically to produce a concept map of ion balance and the pH of the buffer solution. The procedural analysis is useful for determining the stages of task completion used in the electronic activity sheet, in this case using the stages of the PQ4R learning strategy. The formulation of learning objectives is based on basic competencies and indicators of competency achievement listed in the content structure analysis.

3.2. Design of Electronic Activity Sheet

The initial design of the electronic activity sheet was based on the formulation of the basic competencies of the chemistry subject syllabus by (Ministry of Education and Culture, 2017) and the structure of the student activity sheet consisting of the title of the electronic activity sheet, study instructions, materials and student work steps referring to the PQ4R learning strategy. The design of the electronic activity sheet is divided into three material titles, including the nature of the buffer solution, the pH of the buffer solution, and the role of the buffer solution. An electronic activity sheet is created with the help of a sway office website to produce an interactive electronic activity sheet that can be accessed by users via a website link. The activities of students in the electronic activity sheet can be explained as follows:

1. Preview, students read a discourse through the video presented, then asked to find the main idea.
2. Question, students make a question based on the main idea found.
3. Read, students read the material and answer the questions that have been asked.
4. Reflect, students relate the material to the discourse contained in the video at the preview stage

5. Recite, students make the essence of reading and train themselves by answering the questions presented.
6. Review, students communicate the results of the discussion in the class forum.

This stage also produced validity sheets and user response questionnaires as tools used to collect data. The validity sheet is prepared based on the appropriateness of the content, PQ4R characteristics, language, presentation, display, and use of the software. Meanwhile, the user response questionnaire was compiled on the statement responses to the use of an electronic activity sheet during learning. The design of electronic activity sheet and practicum video can see in Figure 2 and Figure 3.

Figure 2. Design of PQ4R-Based Electronic activity sheet Ion Balance and pH of the Buffer Solution.

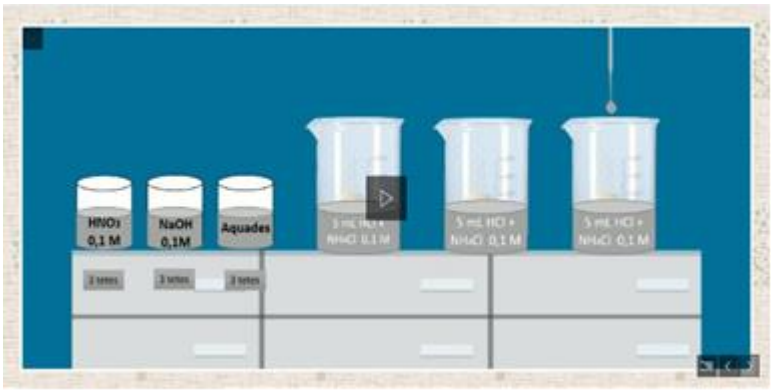

Figure 3. Practicum Video Content in Electronic activity sheet.

3.3. Development of Electronic Activity Sheet

At this stage, the designed product will be validated and tested. Validation is carried out twice, where the results of the 1st validation will obtain comments and suggestions by the validator which is used as improvements for the perfection of the electronic activity sheet, after the improvement of the electronic activity sheet will be carried out a second validation so that the electronic activity sheet is obtained with a valid category without improvement. Validation was assessed by 4 validation experts consisting of 2 material expert lecturers and 2 media expert lecturers, in this case, the material expert assessed the electronic activity sheet based on the feasibility of content, PQ4R characteristics, language, and presentation. Media experts assess the electronic activity sheet based on the feasibility of the display (visual communication design) and the use of the software. The following is a graphic image of the results of the first and second validation by material and media validation experts in Figure 4 and media expert in Figure 5.

Figure 4 and Figure 5 show an increase in the percentage of 1st Validation to 2nd Validation in each feasibility assessment. Feasibility of content in the 1st validation obtained a percentage of 75%

with a valid category, but there are still comments in the form of a small number of practice questions, examples of non-buffer solutions and incorrect pH values, so improvements need to be made. The improved electronic activity sheet was continued for the 2nd validation so that the validation results were obtained by 100% in the valid category and without comments. The validation experts assesses that the electronic activity sheet is in accordance with the indicators that become an assessment of the feasibility of the content of the electronic activity sheet, National Education Standards Agency (2006) explains the feasibility of content of an electronic activity sheet must be able to guide students to explore new information of interest. The feasibility of the PQ4R characteristics in the 1st validation obtained a validation result of 71.42% with a fairly valid category, but there are still comments in the form of discrepancies in the PQ4R stage, material in the read stage, and inappropriate preview discourse terms, so improvements need to be made. The improved electronic activity sheet was continued for the 2nd validation so that the validation results were obtained at 96.42% in the valid category and without comments. According to the validation experts, the electronic activity sheet is in accordance with the PQ4R strategy steps which consist of preview (reading discourse), question (composing questions), read (reading material), reflect (examine information), recite (remember), and review (communicate).

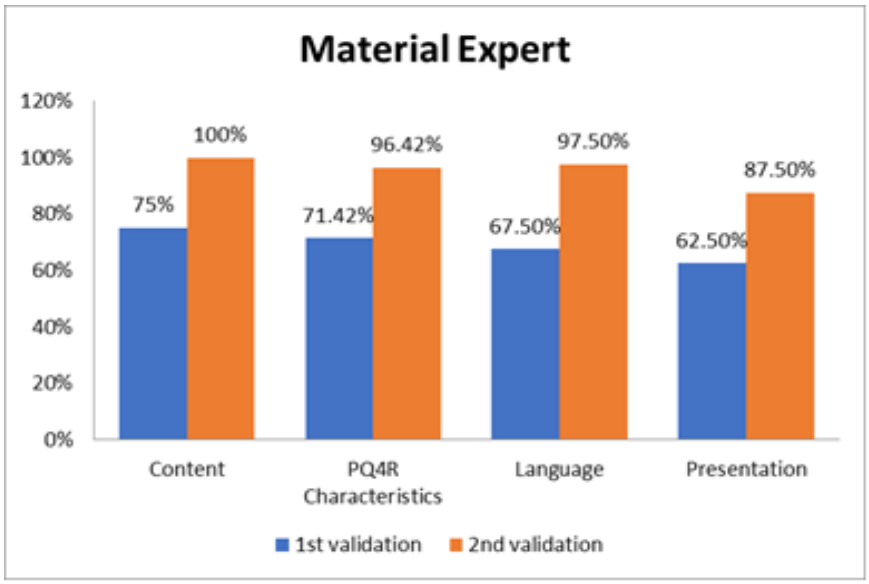

Figure 4. Graph of Validation Result by Material Expert.

The feasibility of the language in the 1st validation yields validation result of 67.50% with a fairly valid category, but there are still comments in the form of redaction questions and inappropriate punctuation, so improvements need to be made. The improved electronic activity sheet was continued for the second validation so that the validation results were obtained at 97.50% with a valid category and no comments. According to the National Education Standards Agency (2006), teaching materials must follow Indonesian writing which means sentence clarity and clarity of relationships between sentences. The use of Indonesian by the guidelines can make it easier for students to interpret the aims and objectives of the electronic activity sheet, according to the validation experts, the electronic activity sheet is by the indicators that become an assessment of the feasibility of language in the electronic activity sheet. Feasibility of presentation in the 1st validation obtained a validation result of 62.50% with a fairly valid category, but there are still comment in the form of additional learning instructions to direct students to see videos or work on questions, so improvements need to be made. The improved electronic activity sheet was continued for the 2nd validation so that the validation result was 87.50% with valid and no comment category. According to the validation experts, the electronic activity sheet has clear activity objectives, coherent systematics

and can build student motivation in learning by student activity sheet rules according to the Ministry of National Education (2008).

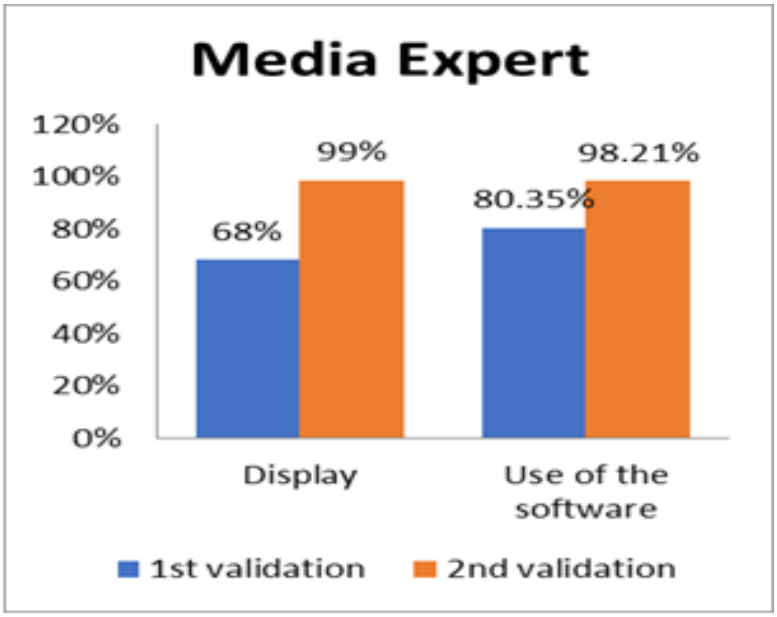

Figure 5. Graph of Validation Result by Media Expert.

The display feasibility on the 1st validation yields validation results of 68.50% with a fairly valid category, but there are still comments in the form of excessive contrasting cover colors, monotonous videos, and small fonts, so improvements need to be made. The improved electronic activity sheet was continued for the second validation so that the validation results were obtained at 99% with valid categories and without comments. According to Fillindity & Manoppo (2019), the use of teaching materials that are arranged with good display proportions will be able to attract students' interest in learning. The feasibility of using the software in the 1st validation resulted in a validation of 80.35% with a fairly valid category, but there are still comments in the form of adding a hyperlink back to the menu, so improvements need to be made. The improved electronic activity sheet was continued for the 2nd validation so that the validation results were obtained at 98.21% with valid categories and without comments. According to the validation experts, the overall use of software from the electronic activity sheet is easy to use, because there is already information on the navigation buttons.

An electronic activity sheet that is declared valid and without revision by the validation experts can be continued at the trial stage to obtain user responses in learning. The one-on-one test at the beginning is useful for eliminating errors in the electronic activity sheet, this test was carried out on students of Senior High School 1 Pekanbaru with different cognitive abilities, namely smart, moderate, and poor. The results of the one-on-one test obtained student opinions in the form of unclear video resolution, a small display of material, and no information on the pH formula of the buffer solution. These opinions will be the basis for improvement by researchers to eliminate errors in the electronic activity sheet, so that a good electronic activity sheet is produced and can be continued for teacher trials and limited trials.

The results of the trial to 3 chemistry teachers and the limited trial to 20 students were 92.59% and 84.87%, respectively, with a very good user response category. The teacher considers that the electronic activity sheet is good and interesting, and the material presented is in accordance with the 2013 curriculum syllabus. The practice questions presented in the electronic activity sheet has led to analytical questions, not only that the electronic activity sheet is also easy to use and the experimental simulation video is very useful help in online learning today. One way to overcome the

problem of students' experimental skills in online learning can use virtual laboratories such as interactive simulations, videos, and animations to convey laboratory experiences (Shidiq et al. 2021). This is in line with what Izzania & Widhihastuti (2020) said that the use of experimental simulation videos in the online learning period can be an alternative solution because it can train science practicum skills. The steps of the PQ4R learning strategy which are the content of the electronic activity sheet is also coherent and clear and can guide students to understand the ion balance material and the pH of the buffer solution. Through the PQ4R strategy, students will understand the material and examine the information used to criticize and have an opinion on the material discussed (Ramdiah, 2012).

4. Conclusion

The PQ4R-based electronic activity sheet on the ion balance material and the pH of the buffer solution has been categorized as "valid" based on the feasibility of content, PQ4R characteristics, language, presentation, display, and software utilization with average scores are 100%, 96.42%, 97.5%, 87.5%, 99%, and 98.21%. The test results for teachers and students were 92.59% and 84.87%, with the user response category is very good. Electronic activity sheet can already be used as a source of learning materials by students, because it can guide students with the stages of the PQ4R learning strategy to understand the concept of ion balance and pH of a buffer solution. The use of an electronic activity sheet is also very helpful in the online learning process which is very dependent on internet access and experimental simulation video content is an alternative solution to improve science practicum skills. Development research is only carried out until the electronic activity sheet is valid and tested on a limited basis, so it is necessary to proceed to the deployment stage to disseminate valid products.

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