ISSN:xxxx-xxxx

Proceedings of the 2nd International Conference on Education, Science Technology and Health (2nd ICONESTH 2024 Universitas Bina Bangsa Getsempena, Sept 10-12, 2024, Banda Aceh, Indonesia

DEVELOPMENT OF STEM-ORIENTED CREATIVE CONTENT BASED ON ELECTRONIC PORTFOLIO IN CHEMISTRY LEARNING

Nahadi[*1], Wiwi Siswaningsih[2], Dini Dwi Apriani[3], Pupung Purnawarman[4], Hayuni R. Widarti[5], Ari S. Shidiq[6], Triannisa Rahmawati[7], Atep R. Nurhadi[8], Qurrotu A. Zahran[9]

[1234789]Universitas Pendidikan Indonesia, Bandung, Indonesia
[5]Universitas Negeri Malang, Malang, Indonesia
[6]Universitas Sebelas Maret, Surakarta, Indonesia

***** Corresponding email: *nahadi@upi.edu*

ABSTRACT

This study aims to develop a STEM-oriented creative content based on electronic portfolio assessment instrument to improve students' critical thinking skills on buffer solution material. The assessment instruments developed were tasks and rubrics. The research was conducted using the research and development method 4D model and was carried out in only three stages, namely define, design, and develop, with limited trials. The research instruments used were interview guidelines, validation sheets, observation sheets, tasks, and rubrics. The participants in this study is XI class students. The tasks developed in this electronic portfolio assessment consisted of three tasks: analysis essay questions, summaries, and practicum reports. The results showed that the instrument was valid and reliable. Based on the results of the limited trial, the electronic portfolio assessment instrument developed can improve students' critical thinking skills on buffer solution material with moderate and high classifications.

Keywords: *electronic portfolio, critical thinking, buffer solution*

INTRODUCTION

Assessment and learning can be a concept known as assessment for learning. This assessment is conducted while students are learning to determine the extent of their learning outcomes, so that strategies can be

developed for where they need to continue learning and how best to get there. Assessment for learning is a continuous assessment process that collects and interprets evidence about student learning outcomes (Rosana, Widodo, Setianingsih, & Setyawarno, 2020). In implementing assessment for learning, it is necessary to provide feedback to students during the learning process to help them evaluate themselves, review their progress, and improve the teaching and learning process. Assessment for learning is one of the approaches in assessment that provides feedback and trains students' skills to assess themselves (Rahmawati, Hartono, & Nugroho, 2015).

In addition to measuring the achievement of learning objectives, assessment also plays a role in identifying deficiencies in the learning process that has been or is being carried out. Therefore, it is very important to create accurate assessments. Regular assessments cannot provide maximum and detailed data about the learning process, so authentic assessments are used to fill this gap. Of the various forms of assessment commonly conducted in schools, portfolio assessment is one example of classroom-based assessment that can be used to measure the level of student achievement and progress. Educational experts have paid attention to the use of portfolios as an assessment tool even though it is a relatively new practice. This is because portfolios have tremendous potential to demonstrate students' full competence (Nahadi, Purnawarman, & Siswaningsih, Development of an Electronic Portfolio Assessment Model in Learning Chemistry to Develop the Habits of Mind and Reasoning of Indonesian Students, 2021).

As part of education reform efforts, incorporating various forms of technology in the learning process must of course be accompanied by assessments that can utilize these technologies. The results of the study show that the use of technology in education has succeeded in increasing student engagement and learning outcomes (Wahyuni, Zaim, Thahar, & Susmita, 2024). Electronic portfolios are one method of utilizing technology in assessment (Zulfikri, 2022). Electronic portfolios are described as the results of student portfolio assignments stored in electronic format. In learning, electronic portfolios are very helpful, especially in secondary and higher education. The results of student assignments are collected in an electronic storage, so that the results of the assignments can be viewed anytime and anywhere. According to Fikri (2014), the development of electronic portfolios for learning assessment is one way to overcome the weaknesses of conventional portfolios that require a lot of space and limited document access.

In facing learning in the 21st century, in addition to having the knowledge and abilities of digital literacy, information literacy, media literacy, and mastery of information and communication technology, each individual needs to have critical thinking skills (Frydenberg & Andone, 2011). According to Reta's opinion in Putri, Nevrita, & Hindrasti (2019) education in

schools is currently not handled optimally so that the critical thinking skills of elementary school graduates are low.

An evaluation tool that can be used to measure students' critical thinking skills is needed because measurement is very important to know where students are when they are involved in certain activities or activities. In the field of education, measurement is intended to measure certain qualities or traits of students (Kartimi & Liliasari, 2012). This certainly also applies in chemistry learning. In learning, evaluation tools are needed that can assess students' understanding of material concepts as well as their critical thinking skills.

Buffer solution material is one of the chemical materials that requires high understanding. Studying buffer solution material requires an understanding of other materials, such as the concept of mole, acid-base, solution, stoichiometry, and chemical equilibrium. Weak mastery of supporting concepts can have an impact on difficulties in understanding buffer solution material. Based on research conducted by Firdaus, Rusmana, & Zulfadli (2021) on grade XI students at Madrasah Aliyyah Swasta Darul Ihsan, there were 32.3% of students understood the concept, 38.1% did not understand the concept, 20.6% misconceptions, and 9% errors. The most difficult indicators to understand are the indicator to determine the relationship between buffer solutions and the concept of chemical equations and the indicator to calculate the pH of acid buffer solutions.

Based on the results of the interviews conducted, it is known that assessment using portfolios has been done but very rarely because it takes a long time. In addition, teachers lack understanding of assessment using portfolios. In the assignment, giving feedback by the teacher to each student is difficult to do because time is very limited and the teacher has never specifically designed an assessment instrument to train critical thinking skills. Teachers believe that if the assessment is too difficult, it will burden students and cause students who have learning difficulties to fall further behind in understanding the subject matter.

Some research results that are relevant to this study, including research by Nahadi, Purnawarman, & Siswaningsih (2021), state that the electronic portfolio assessment instrument developed meets the validity and reliability indices which are sufficient as valid and reliable questions so that it can be used as content to build an electronic framework and portfolio assessment model. Arifin (2021) showed that with electronic portfolio assessment students can develop themselves into independent individuals and have self-assessment skills in HOTS-based learning. Zulfikri (2022) concluded that electronic portfolio assessment can improve as many as five critical thinking indicators and there is a moderate increase in students' critical thinking skills.

With the background described, the development of electronic portfolio assessments to improve critical thinking skills is still largely unused in the chemistry learning process. Specifically, regarding buffer solutions, there is

no electronic portfolio assessment developed to improve students' critical thinking skills. Therefore, researchers conducted research with the title Development of Electronic Portfolio Assessments to Improve Students' Critical Thinking Skills on Buffer Solution Material.

METHODS

The research method used is using the research and development (R&D) method. In this research and development of electronic portfolio assessment strategies, not all R&D steps were carried out, only up to the limited trial stage in the third stage of the 4D model research and development steps, namely development. This research was conducted by involving high school students in class XI IPA who had studied buffer solution material.

The research instruments used to collect data included interview guidelines, instrument validation sheets, assessment observation sheets, tasks, critical thinking skills assessment rubrics, and portfolio assessment rubrics.
The data obtained were analyzed using qualitative methods in the form of a description of the findings during the implementation process and quantitative methods to determine the quality of the instrument in terms of content validity and reliability, as well as to determine the effectiveness of the developed electronic portfolio assessment in improving students' critical thinking skills on buffer solution material.

RESULTS AND DISCUSSION

Instrument quality based on validity and reliability

The validated electronic portfolio assessment instruments are tasks and assessment rubrics. The things that were checked were the suitability of indicators and tasks and the suitability of tasks and rubrics. Of the 17 aspects of assessment developed, there are two aspects of assessment that are said to be invalid in the category of suitability of indicators with tasks and there is one aspect of assessment that is said to be invalid in the category of suitability of tasks with rubrics.

The validity of the electronic portfolio assessment instrument developed to improve students' critical thinking skills on buffer solution material is valid with a CVR value of 0.60-1.00. Invalid critical thinking skills task indicators can then be corrected as stated by Wilson et al. (2012). Invalid and valid critical thinking skills task indicators with conditions are corrected according to the suggestions given.

In this study, to determine the reliability of the electronic portfolio instrument developed, the reliability test was carried out using the inter-rater method, which means that different raters assessed the tasks done by the same students with the same assessment rubric. There were four raters in this study.

Based on the results of calculations, the Cronbach's Alpha value of the instrument developed ranged between 0.641 and 0.929. The results of the analysis of the Cronbach's Alpha value show that only three aspects of the assessment have excellent reliability, 13 aspects of the assessment have good reliability, and 1 aspect of the assessment has acceptable reliability.

Google Classroom as an electronic portfolio

Google Classroom as a medium for implementing electronic portfolio assessment. The implementation of electronic portfolio assessment using the Google Classroom application includes giving tasks by researchers, collecting the results of task work by students, and means of communication in the form of providing feedback and responses from students. The results of the limited trial showed that Google Classroom can be used well as a medium for electronic portfolio assessment because it can be used to collect tasks and provide feedback easily. This is in line with Rahmanto & Bunyamin's (2020) that portfolio assessment with Google Classroom is an innovative learning process assessment and is a beneficial assessment method for teachers and students.

Students' Critical Thinking Skills on Each Task

Students' critical thinking skills on buffer solution material are measured by calculating the scores obtained by students in each task before and after feedback is given. Feedback is done because it is part of assessment for learning that will help students improve their learning outcomes. A comparison of students' critical thinking skills scores on all tasks is presented in Figure 1.

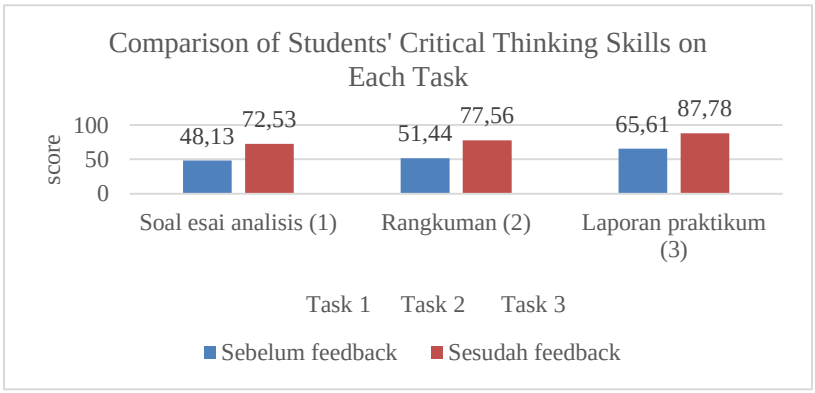

Figure 1.Comparison of student's critical thinking skills on Each Task

Based on figure 1, the results of the limited trial showed an increase in students' critical thinking skills on buffer solution material between before and after providing feedback. Task 1 has an increase in average score from

48.13 to 72.53 with an N-Gain value of 0.47 (medium), task 2 has an increase in average score from 51.44 to 77.56 with an N-Gain value of 0.54 (medium), and task 3 has an increase in average score from 65.61 to 87.78 with an N-Gain value of 0.64 (medium). According to the learning success category, students' success increased from quite good to good in task 1 and 2, and good to very good in task 3. This proves that feedback affects the improvement of student learning outcomes.

Assessment of Electronic Portfolio Products with Rubric

The results of the task work after improvement will be selected as a sample of the student portfolio. The selected task is the task with the highest score among other tasks. The number of best tasks from students that are used as portfolio samples is presented in Figure 2.

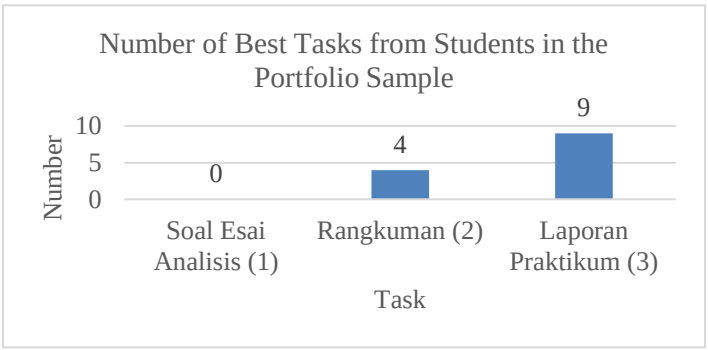

Figure 2. Number of Best Tasks from Students in the Portfolio Sample

Based on figure 2, the practicum report is the most selected portfolio sample. This happens because in making practicum reports, students have done task 1 and task 2 so that their understanding of buffer solutions is getting better.

After obtaining a portfolio sample, an assessment was then carried out using a portfolio assessment rubric. The aspects assessed on this portfolio sample include several categories including portfolio content (sample selection, accuracy of chemical knowledge, and novelty), portfolio presentation (document organization, explanation narrative, and collection time), and portfolio appearance (multimedia and design/layout).

CONCLUSION

Based on the results, the STEM-oriented creative content based on electronic portfolio assessment instrument developed can improve students' critical

thinking skills on buffer solution material with moderate and high classifications.

ACKNOWLEDGEMENT

We would like to thank the Rector of UPI and DRTPM for funding and supporting this research and publication very well.

REFERENCES

Arifin, M. H. (2021). Development of Electronic Portfolios and Self-Assessment Based on High Order Thinking Skills in Pancasila and Citizenship Learning at Students of Al-Islam Bandung Polytechnic. *Journal of Physics: Conference Series., 1764*(1). doi: https://doi:10.1088/1742-6596/1764/1/012144

Arikunto. (2007). *Prosedur Penelitian Suatu Pendekatan Praktik.* Jakarta: Rineka Aksara.

Bhatnagar, R., Kim, J., & Many, J. E. (2014). Candidate surveys on program evaluation: Examining Instrument reliability, validity, and program Effectiveness. *American Journal of Educational Research, 2*(8), 683-690.

Fikri, K. (2014). Pengembangan E-Portofolio Dalam Project Based Learning Pada Mata Kuliah Animal Physiology Pada Program Studi Pendidikan Biologi. *Pancaran Pendidikan, 3*(2), 17-24.

Firdaus, M., Rusman, R., & Zulfadli, Z. (2021). Analisis Kesulitan Belajar Siswa pada Materi Larutan Penyangga dengan Menggunakan Four-Tier Multiple Choice Diagnostic Test. *Chimica Didactica Acta, 9*(2), 57-61.

Firman, H. (2013). *Evaluasi Pembelajaran Kimia.* Bandung: FMIPA UPI.

Frydenberg, M. E., & Andone, D. (2011). Learning for 21st Century Skills. *IEEE's International Conference on Information Society*, (pp. 314-318). London.

Girsang, B., Sinaga, E. A., Tamba, P. G., Sihombing, D. I., & Siahaan, F. B. (2022). Analisis Kemampuan Berpikir Kritis Siswa Dengan Model Program For International Student Assesment (PISA) Konten Quantitiy Pada Materi Himpunan di Kelas VII SMP HKBP Sidorame Medan. *Journal of Mathematics Education and Applied*. doi:https://doi.org/10.36655/sepren.v3i2

Hestiana, D. R. (2020). The Effect of Problem Based Learning Based Sosio-Scientific Issues on Scientific Literacy and Problem-Solving Skills of Junior High School Students. *Journal of Science Education Research, 4*(1). doi:https://doi.org/10.21831/jser.v4i1.34234

Juhanda, A., Wulan, A. R., & Fitriani, A. (n.d.). Pengembangan Asesmen Portofolio Elektronik (APE) dalam Menilai Sikap Ilmiah dan Penguasaan Konsep Siswa SMA pada Laporan Praktikum Pencemaran

Lingkungan. *Prosiding Seminar Nasional Pendidikan Biologi*, (pp. 317-327).

Kartimi, K., & Liliasari, L. (2012). Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Peringkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia, 1*(1), 122852.

Nahadi, N., Purnawarman, P., & Siswaningsih, W. (2021). Development of an Electronic Portfolio Assessment Model in Learning Chemistry to Develop the Habits of Mind and Reasoning of Indonesian Students. *Journal of Physics: Conference Series, 1788.*

Nahadi, N., Siswaningsih, W., Apriani, D. D., Daniati, D., Purnawarman, P., & Lestari, T. R. (2023). Development of an Electronic Portfolio-Based Assesment Strategy to Improve Student's Habits of Mind in Buffer Solution Material. *Journal of Engineering Science and Technology, 18*(3), 1401-1412.

Nickerson, R. S. (1985). Understanding understanding. *American Journal of Education, 93*(2), 201-239. doi:http://dx.doi.org/10.1086/443791

Purwanto. (2012). *Metode Penelitian Kualitatif.* Yogyakarta: Pustaka Pelajar.

Putri, O. D., Nevrita, N., & Hindrasti, N. E. (2019). Pengembangan instrumen penilaian keterampilan berpikir kritis siswa SMA pada materi sistem pencernaan. *BIOEDUKASI: Jurnal Pendidikan Biologi, 10*(1), 14-27.

Rahmanto, M. A., & Bunyamin, B. (2020). Efektivitas Media Pembelajaran Daring Melalui Google Classroom. *Jurnal Pendidikan Islam, 11*(2), 119-135. doi:https://doi.org/10.22236/jpi.v11i2.5974

Rahmawati, I. L., Hartono, & Nugroho, S. E. (2015). Pengembangan Asesmen Formatif untuk Meningkatkan Kemampuan Self Regulation Siswa pada Tema Suhu dan Perubahannya. *Unnes Science Education Journal, 4*(2), 842-850.

Riandeni, A., Yulianti, D., & Distrik, I. W. (2022). Pengembangan Instrumen Penilaian Kognitif Berbasis Student Active Learning untuk Meningkatkan Critical Thinking Peserta Didik Sekolah Dasar. *Jurnal Basicedu, 6*(3), 4720-4730.

Rosana, D., Widodo, E., Setianingsih, W., & Setyawarno, D. (2020). Pelatihan Implementasi Assessment Of Learning, Assessment For Learning Dan Assessment As Learning Pada Pembelajaran IPA SMP di MGMP Kabupaten Magelang. *Jurnal Pengabdian Masyarakat MIPA Dan Pendidikan MIPA, 4*(1), 71-78. doi:https://doi.org/10.21831/jpmmp.v4i1.34080

Sudiana, N. (2012). *Penilaian Hasil Proses Belajar Mengajar.* Bandung: PT. Remaja Rosdakarya.

Wahyuni, S., Zaim, M., Thahar, H. E., & Susmita, N. (2024). Revolusi Media Pembelajaran Digital: "Membuka Peluang dan Menangani Tantangan dalam Pembelajaran Bahasa". *Visipena, 15*(1), 51-66. doi:https://doi.org/10.46244/visipena.v15i1.2691

Wilson, F. R., Pan, W., & Schumsky, D. A. (2012). Recalculation of the critical values for Lawshe's content validity ratio. *Measurement and evaluation in counseling and development*, *45*(3), 197-210.

Zulfikri, K. (2022). *Pengembangan Asesmen Portofolio Elektronik Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa Pada Materi Asam Basa*. Universitas Pendidikan Indonesia.