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Development of a Video on How to Make Synthetic Indicators in the Laboratory to Improve Practicum Competence of Prospective Chemistry Teachers

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Abstract: The competence to make synthetic indicators is terribly required by chemistry teachers in high school in order that the implementation of practicum can run more effectively and efficiently. This study aimed to develop a practicum video on how to make synthetic indicators and find out the quality of the developed video. This study was a Research and Development (R&D) study with 4D development model (Define, Design, Develop, and Disseminate). The product was a practicum video on how to make synthetic indicators, in the form of MP4, containing the creation of phenolphthalein, starch, Tollens, and Fehling indicators. The product was assessed by one material expert, one media expert, and four reviewers (high school chemistry teachers). The results of product assessments based on quality, from media expert, it got a percentage of 96% in the very good category; from material expert, it got a percentage of 95% in the very good category; and from reviewers, it got a percentage of 98.33% in the very good category. Furthermore, the video was also responded very well by prospective chemistry teachers with an ideal percentage of 98%. Based on the results, it can be concluded that the developed product is feasible to be used in the learning process to improve the ability of prospective chemistry teachers to make synthetic indicators in the laboratory.

Keywords: Practicum Competence; Practicum Video; Synthetic Indicators

Introduction

The key to succeed in education in the era of industrial revolution 4.0 is technology-based learning (Surani, 2019). The availability of technology-based media makes learning more effective because it is not limited by space and time (Usman, 2017). Technology-based learning can facilitate teachers to achieve learning goals (Fitriani et al., 2018). However, the facts show that the use of technology in the learning process has not been evenly distributed. Based on research conducted by Sahelatua et al. (2018) there were many schools that did not apply technology in the learning process. There were still many teachers who were confused about integrating technology with learning materials (Wibowo & Hamrin, 2012).

Technology-based learning by using video becomes a trend in the world of education today (Agustini & Ngarti, 2020). Video can contain insight and knowledge about learning materials (Kurniawan et al., 2018). Video is also used as a reference source of knowledge by teachers and students (Erniwati et al., 2014). Learning by using video is considered to be easier and more flexible for the reasons; (1) the use of time is more efficient; (2) learning opportunity is more active; (3) the materials can be explained more clearly, (4) each individual's different learning style is solved; and (5) the burden on teachers to use the lecture model is reduced in the teaching and learning process (Pratama et al., 2018). To visualize the learning materials, video is equipped with a combination of sound, images, and music. Here, students' motivation and interest to learn can be

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increased (Pradilasari et al., 2019). Based on research conducted by Asmara et al. (2017), there was still few chemistry learning videos in schools that was used by teachers in the learning process. As a result, teachers were less than optimal to provide comprehension for their students.

Teacher is one of the important factors to improve the quality of education (Zulhimma, 2015). In term of improving teachers' quality, the matter to be noted is not only about their welfare but their competencies also (Rahmawati & Astuti, 2017). The competent teacher is teacher who is able to educate students in order to have general and specific life skills (Sutardi & Sugiharsono, 2016). The success of teachers to create a learning atmosphere depends on their competencies (Sopandi, 2019). According to Heriswanto (2018), competence has a significant effect on teachers' performance in the teaching process. However, based on the evaluation of Research on Improving Education Systems (RISE) Program in 2018, in term of competence, teachers who were able to score above the general achievement criteria did not reach 50%. This indicates that there are still many incompetent teachers to teach their students. Therefore, as a prospective teacher, the problem above needs to be solved.

Professional competence is the ability to master the subjects broadly and deeply (Law of the Republic of Indonesia Number 14 of 2005 about Teachers and Lecturers, 2005). The competence of practicum is one of the professional competencies that prospective teachers must possess (Agustina & Saputra, 2016). Prospective teachers must have experience and provisions to conduct practicum in school laboratory (Hamadi, 2018). This competence is able to integrate prospective teachers' hands-on and minds-on so that they can guide students to conduct experiments properly and correctly in accordance with scientific principles (Supriatno, 2013). According to research conducted by Nisa (2017), learning with the practicum method could improve students' understanding and ability to think critically. However, the lack of teachers' understanding and skills to manage practicum activity was another problem. Therefore, this activity was rarely carried out in the learning process (Pujiastutik, 2017).

The competence of practicum includes observation, classification, interpretation, communication, planning and conducting investigations, submitting proposals, and asking questions (Suryaningsih, 2017). In term of material preparation and laboratory equipment management, the competence of planning and conducting investigations are required by teacher. This competence is required to support the practicum activity in school in order to run smoothly (Apriani et al., 2016). Creating indicator solutions is an important part of material preparation which can be conducted by teachers (Ramdan, 2017). In the preliminary study, the interview with four chemistry teachers in DI Yogyakarta showed that teachers tend to buy indicator solutions rather than make them in the laboratory. The reasons are that they do not want to be bothered and they also avoid losses to create indicator solutions even though the ingredients to create indicator solutions are available in the laboratory. In addition, there are many teachers who have not understood how to make indicator solutions (Hasruddin & Rezeqi, 2012).

Indicator solutions are required in chemistry labs to identify and determine the components and the properties of a compound (Rahmawati et al., 2016). In general, there are two kinds of indicator solutions used in schools, namely natural indicator and synthetic indicator (Lestari, 2016). Indicator solutions that are often used in students' practicum in school include phenolphthalein, benedict, tollens, and amylum indicators (Maulika & Rizmahardian, 2019). Based on research conducted by Nuryanti et al. (2010), many synthetic indicators were sold in the market but they were relatively expensive; their sterility was not guaranteed; and their availability was limited. Therefore, making the indicator solution independently is considered more effective.

Any effort to cultivate the prospective chemistry teachers in order to have the ability to make synthetic indicators is through practicum video. This study focuses on developing practicum video. Hopefully, through the developed video, the prospective teachers can improve their practicum competencies in the laboratory. In addition, the video can also be used as a source of materials in the learning activities and it is easily accessible anytime and anywhere.

Method

The development of video was conducted through Research and Development (R&D). The model of development which was used in this study adopted a 4-D model consisting of four stages, namely Define, Design, Development, and Disseminate (Thiagarajan et al., 1974). However, in this study, it was limited to the development stage.

The stage of define aimed to determine needs and collect various information related to the product to be developed. At this stage, chemistry teachers and chemistry education students were interviewed. The stage of design aimed to plan the product to be developed. At this stage, there are some steps which needed to be done. They were media selection, format selection, making storyboard, data collection instrument, and initial design. The development stage included the process of validity test, revision, and product trial with the aim of producing a final product. The validity test of product aimed to obtain data and information concerning the feasibility level of the developed product (Sugiyono, 2013). The validity test of product used expert judgment. At this stage, the developed video was also assessed. The assessors in this study were one material expert, one media expert, and four reviewers (high school chemistry teachers). Suggestions and comments which were gained from the results of the validity test were used as material for product improvement. The trial was conducted on a small scale, involving ten students of chemistry education study program (prospective chemistry teachers) who came from various universities as responders toward the developed product.

The instruments which were used in this study included product validation sheets, product quality assessment sheets (using a Likert scale questionnaire), and student response sheets (using a Guttman scale questionnaire). For material expert, the assessment sheet consisted of material aspects and practical competencies. The assessment sheet for media expert consisted of video aspects. The assessment sheet for reviewers consisted of material aspects, practical competencies, and videos.

Data analysis technique of product quality assessment was carried out by converting the results of product quality assessments, which were in the form of letters (qualitative data) into scores (quantitative data) (Riduwan, 2013) based on a Likert scale with the provisions which can be seen in Table 1.

Tabel 1. The Rules of Scoring

Description	Skor
Very Good	5
Good	4
Fair	3
Poor	2
Very Poor	1

Furthermore, the average score of all assessment aspects and each assessment aspect were calculated by using the Formula 1.

$$\bar{X} = \frac{\sum x}{n} \quad (1)$$

Description:
$\bar{X}$ = Average score
ΣX = Average score of each assessors
n = The number of assessors

After obtaining scores, the scores were then converted into categorical (qualitative) according to the ideal assessment category (Sukardjo & Sari, 2008). It can be seen in Table 2.

Tabel 2. Ideal Assessment Criteria

Score Range	Category
$Xi + 1.8\ SBi < \bar{X}$	Very Good
$Xi + 0.6\ SBi < \bar{X} \leq Xi + 1.8\ SBi$	Good
$Xi - 0.6\ SBi < \bar{X} \leq Xi + 0.6\ SBi$	Fair
$Xi - 1.8\ SBi < \bar{X} \leq Xi - 0.6\ SBi$	Poor
$\bar{X} \leq Xi - 1.80\ SBi$	Very Poor

Data analysis technique on prospective teachers' responses was conducted by converting qualitative data into quantitative data in the form of scores by using the Guttman scale (Sugiyono, 2013). It can be seen in Table 3.

Tabel 3. The Rules of Scaling with Guttman Scale

Description	Score
Yes	1
No	0

After converting qualitative data into quantitative data in the form of scores, the percentage of the ideal product was then calculated as a whole and each aspect with the Formula 2:

$$\text{Ideal Presentation} = \frac{\text{Score reached}}{\text{Ideal max score}} \times 100\% \quad (2)$$

Result and Discussion

The product to be developed in this study was a practicum video. The video contained how to make synthetic indicators. In term of developing the video, a 4D development model was used in this study. The use of the 4D development model was based on the development steps according to the development needs. Besides that, the focus of this study was not on the design or learning system but it focused on the product as a whole (Zunaidah et al., 2014).

The stage of define was conducted by interviewing four chemistry teachers and ten students of chemistry education (prospective chemistry teachers) who came from various universities. The interview was conducted in the preliminary study. Based on the interview with chemistry teachers, there were still many teachers who did not understand how to make synthetic indicators well. Teachers were overwhelmed by preparing practicum materials independently so they preferred to buy them in the market. In addition, most teachers only got theory or knowledge about making indicator solutions and they have never practiced it in school laboratory. Meanwhile, based on the interview with students, information was obtained. The results showed that there was no practicum to make synthetic indicators in university. Students also did not have any reference about how to make synthesis indicators either from books, videos, or other sources.

The stage of design was carried out by selecting the media, selecting the design format, making storyboards, making data collection instruments, and making initial designs. The product to be developed in the study was in the form of a practicum video. The application used for video editing was Adobe Premiere pro CC 2022. The application was selected because it was able to create and edit videos with maximum result quickly and easily. In addition, the application also had complete facilities in editing program so that the process of video editing was easier (Setiyaningsih, 2022). The video of how to make synthetic indicators of phenolphthalein, amylum, tollens, and fehling was really required in order to facilitate chemistry teachers in creating these indicators because these indicators were always used for practicum in high school. In term of making synthetic indicators in a laboratory, practitioner was required to understand how to prepare materials and manage equipment in the laboratory. The knowledge above could also be used as a basis for conducting other practicums. The practicum video contained the safe work procedures, introduction of materials, stages of creation, and the correct management of tools and materials. The practicum video was arranged systematically so that it could be used easily.

The product in this study was made by interviewing a chemistry laboratory assistant. Interview was conducted to find out how to make good and correct synthetic indicators, both technically and procedurally. After interviewing a chemistry laboratory assistant, a storyboard was made. According to Effendy (2002), storyboard is a number of sketches, describing the actions in the film, which are arranged regularly with dialogue and time or scene descriptions for the purpose of pre-visualizing. Storyboard was made to facilitate in designing video which was developed. Furthermore, the storyboard was developed and transformed into a practicum video. At this stage, there were some steps. First, prepare a raw video of how to make synthetic indicator which was taken in the laboratory. Second, edit the video by using Adobe Premiere Pro CC 2022 and make an intro.

At this stage, the video intro was made by splitting, cutting, accelerating and slowing the video speed, giving motion and synchronizing the images with the music beats. Furthermore, the video intro which contained the opening narration was edited by inserting dubbing and subtitles on the video. The next stage is to edit the scene of tool and practicum material introduction. At this stage, the footage of tools and practicum materials that have been shot previously were imported. After that, motion and dubbing were also inserted. Editing the scene of practicum material preparation was done by editing the footage of material preparation, cutting, trimming, and giving motion. Furthermore, calculation narration and explanation through dubbing and subtitles were added.

The process of editing the scene in the practicum process was done by cutting, speeding up and slowing down the video speed, adding subtitles, adding dubbing and motion, and synchronizing video with dubbing.

Furthermore, the closing scene was edited by adding closing footage, putting background music on the end of the video, and adding closing credits. The last stage of practicum video editing was the final touch in order to beautify and add video's attractiveness. The final touch included giving transition effects to each scene, providing color grading, adding background music, and adding video credits at the closing scene. This stage can be seen in Figure 1.

The video was made in full HD (High Definition) format. The full HD Video is a video which has higher resolution than the average video which uses HD format. It had high resolution picture which was 1080p (Firdaus et al., 2021).

The final product was in the form of a practicum video which contained how to make synthetic indicators (phenolphthalein, amylum, Tollens, and Fehling). The video presented the safe work procedures, preliminary theory, introduction to the tools and materials in the practicum, stages of making indicators, and testing of the indicators that have been made. The average video had duration of 3-6 minutes. The video was presented with the attractive cover photos. The cover photos in the video served to attract viewers' attention and those also could be as cover for the video. The cover video can be seen in Figure 2.

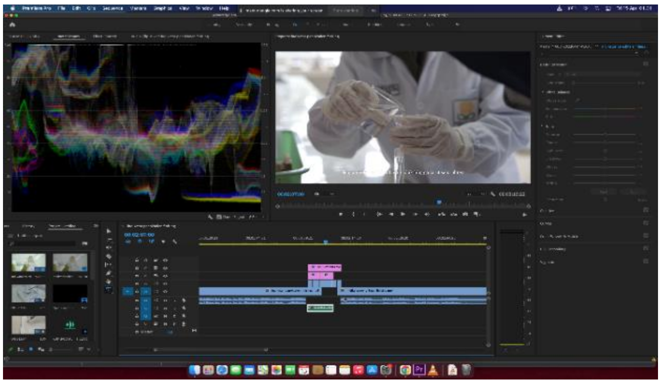

Figure 1. The process of editing the whole video

Figure 2. The cover video

The practicum video which has been developed was presented systematically by being divided into several scenes which included:

The scene one was a video intro that contained the safe work procedures. The safe work procedures included wearing a laboratory coat, medical mask, and latex gloves. This scene can be seen in Figure 3.

FIgure 3. Safe work procedures

The scene two was in the form of an introduction. It contained initial materials (about indicators) which have been developed. Below are the explanations of various indicators:

Phenolphthalein indicator

Phenolphthalein indicator is an acid-base indicator. The function of phenolphthalein indicator is to find out the end point of the titration process. The phenolphthalein indicator has a pH range of 8.2-10. A positive test on a sample with an indication of base is marked with a color change to pink while a sample with an indication of acid is colorless (Chang, 2004). An example of using the phenolphthalein indicator is used in the acid-base titration process

Starch indicator

Starch indicator is an indicator that serves to identify the presence of iodine in the sample. A positive test is indicated by a change in the color of sample to dark blue (Sastrohamidjojo, 2018). An example of using starch indicator is to identify the level of iodine in salt.

Tollen indicator

Tollen indicator is an indicator that functions to identify the presence of aldehyde compounds in the sample. A positive test is indicated by the formation of a silver mirror on the test tube wall (Sunarya, 2013). An example of the use of this indicator is to determine the level of formalin in a sample.

Fehling indicator

Fehling indicator is an indicator that serves to detect the reducing sugar in the sample. A positive test is indicated by the precipitation of a brick red in the sample (Brady, 1999). An example of its use is to identify the reducing sugar in staple foods. The scene intro can be seen in Figure 4.

Figure 4. Video intro

The scene three was an introduction to tools and materials which were used in the practicum. To clarify the name of tools or materials, the tools and materials were shown one by one in the video. This scene can be seen in Figure 5.

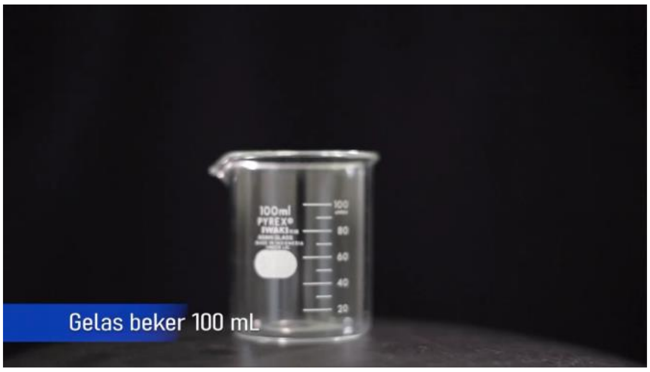

Figure 5. The introduction to tools

The scene four contained how to make synthesis indicators. In term of how to make Fehling indicator, the material preparation was also presented in the video. This scene can be seen in Figure 6.

Figure 6. The Process of Practicum

At the scene Five, the indicators that have been made were tested. The phenolphthalein indicator test was carried out in NaOH solution and a positive result which was indicated by color change of sample to pink was obtained. The starch indicator test was conducted on an iodine solution and a positive result which was indicated by color change of sample to dark blue was gained. The result above was in accordance with the result of starch test carried out in term salt (Silviana et al., 2019). Tollen indicator test was conducted on formalin solution and a positive test result which was indicated by the formation of silver mirror on the wall of the test tube. This result was in accordance with a study conducted by Marliza (2019). The study showed that the identification of formalin in salted fish was indicated by the formation of the silver mirror on the wall of the test tube. Fehling indicator test was carried out on a glucose solution. A positive result which was indicated by the formation of brick red precipitation in the sample was obtained. This result was also in accordance with the study conducted by Fitri et al. (2020). The results showed that the Tollens test on glucose gave positive results, as indicated by the formation of silver mirror deposits. This scene can be seen in Figure 7.

Figure 7. Tollen Test

The scene six was the closing video. The scene contained the closing narration and the closing credits of the video. The closing scene can be seen in Figure 8.

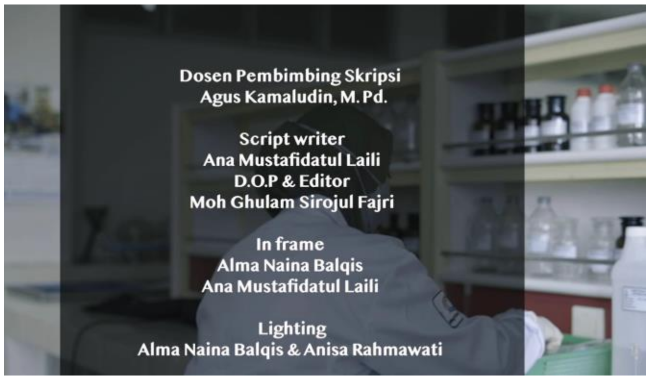

Figure 8. The Closing Video

The stage of development was conducted by developing the initial design of the product. The scenes that have been designed in the storyboard were developed and realized in order to gain the real product. The video was taken in the chemistry laboratory of UIN Sunan Kalijaga by using lighting equipment, DSLR cameras and other equipment such as microphones and tripods. After all the scenes were completed, they were combined by using the Adobe Premiere pro CC 2022 application.

After making the video, the video was tested based on the quality of media and material. This stage aimed to validate the product that has been made (Setyosari, 2016). The validity test was carried out by material expert and media expert. Media expert had a role to validate and assess from the video aspect. The result of video quality assessment according to media expert can be seen in Table 4

Table 4. The Assessment on Product Quality by Media Expert

Assessment Aspect	∑Score	∑ Ideal Maximum Score	Ideal Percentage (%)	Category
Video	25	25	100	Very Good
Total	24	25	96	Very Good

Based on Table 4, it can be concluded that according to media expert, the quality aspect of the practicum video on how to make synthetic indicators was categorized as Very Good overall. The total score which was obtained was 24 with an ideal percentage of 96% so that the practicum video was feasible to be used.

Furthermore, the material expert validated and assessed products based on material aspects and practicum competence. The assessment by material expert can be seen in Table 5.

Table 5. Assessment on Product Quality by Material Expert

Assessment Aspects	∑Score	∑ Ideal Maximum Score	Ideal Percentage (%)	Category
Material	10	10	100	Very Good
Practicum Competence	9	10	90	Very Good
Total	19	20	95	Very Good

Based on Table 5, it can be concluded that according to the material expert, the material and practicum competence aspects presented in the video were categorized as very good category. At this assessment, the total score which was gained was 19 with the ideal percentage of 95%. The developed media was categorized to be theoretically feasible if it passed the validation stage (Andriana et al., 2020). According to Muhafid et al. (2013), after passing the validation stage, the developed product was feasible to be used. Therefore, the practicum video on how to make synthetic indicators can be used by prospective chemistry teachers as a learning support material in order to improve their practicum competencies.

After the product had obtained validation from the experts, the product was then assessed by reviewers. The assessment aimed to determine the quality of the developed product. The results of the assessment by reviewers can be seen in Table 6.

Table 6. Assessment on Product Quality by Reviewers

Assessment Aspects	∑Score	∑ Ideal Maximum Score	Ideal Percentage (%)	Category
Material	39	40	97.5	Very Good
Practicum Competence	39	40	97.5	Very Good
Video	99	100	99	Very Good
Total	177	180	98.33	Very Good

Table 6 shows that the total assessment score was 177, with an ideal percentage of 98.33 percent. Afterwards, it can be stated that the quality of the practicum video on how to create synthetic indicators received a very good score and it is worthwhile to use.

The next stage was to test prospective chemistry teachers on a small scale by using a questionnaire. The sample consisted of 10 chemistry education students from UIN Sunan Kalijaga Yogyakarta, UIN Sayyid Ali Rahmatullah Tulungagung, Muhamadiyah University Semarang, Sebelas Maret State University, Yogyakarta State University, Islamic University of Indonesia, and Surabaya State University. The responses obtained from prospective chemistry teachers were used to measure the quality of the practicum video. The results of the responses of prospective chemistry teachers can be seen in Table 7.

Table 7. Prospective Chemistry Teachers' Response to The Product

Assessment Aspects	∑Indicator	∑Score	∑ Ideal Maximum Score	Ideal Precentage (%)
Practicum Preparation	2	20	20	100
Practicum Technique	2	19	20	95
Practicum Process	2	19	20	95
Presentation	2	20	20	100
Advantage	2	20	20	100
Total	10	98	100	98

Based on Table 7, it can be seen that the total score in all aspects was 98. The ideal percentage of all aspects was 98%. This showed that the content and format of the video could attract the prospective teachers to use it in the learning process. In addition, the prospective teachers also could get new knowledge in order to improve their practicum competencies. This study was in line with the previous research conducted by Dewi (2019). The previous research showed that the use of practicum video-based media was considered effective for use in a learning process. Furthermore, based on an analysis of user responses to chemistry practicum video, a high percentage which was indicated by users' satisfaction from the developed video was obtained. Therefore, the practicum video can be used in the learning process in the university.

This study developed the design and content of previous research by taking material which was still rarely discussed in other learning videos. The material was the manufacture of phenolphthalein, amylum, tollens, and fehling indicators. There we many learning videos but did not present the content completely and systematically. Meanwhile, the developed video in this study was arranged systematically in order to be able to facilitate prospective teachers in understanding the material presented in the video. The video did not only contain tutorial but also came with theory and testing to prove the validity of the indicators which have been made. The video presented how to manage practicum tools properly and correctly and how to work safely. The video was also packaged as attractively as possible with good quality in terms of images and audio so that prospective teachers were comfortable using it as learning resources in order to improve their practicum competencies.

There were difficulties in developing the practicum video. They were accuracy and patience in entering each video footage; synchronizing it with dubbing; adjusting video trim with music beats in making the intro; putting on motion and subtitles; writing the terms of chemical compounds which were less efficient due to the absence of special features; rendering process which took a long time due to slow internet speed and the large number of components in the video.

Conclusion

Based on the study that has been done, a video on how to make phenolphthalein, starch, tollens, and fehling indicators has been developed. The contents of video consist of the title and purpose of the practicum, preliminary theory, introduction to tools and materials, material preparation stage, and indicator testing stage. Moreover, the video also presents the safe work procedures. Based on assessment on the video quality by media expert, the product gets a percentage of 96% in the Very Good category. According to assessment by material expert, the product gets a percentage of 95% in the Very Good category. Moreover, based on assessment by reviewers, the product also gets a percentage of 98.33% in the Very Good category. The video is responded very well by prospective chemistry teachers with a percentage of 98%. Therefore, the practicum video which has been developed is feasible to be used to help the prospective teachers to improve their competencies.

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Author Contributions

Ana Mustafidatul Laili contributes to conceptualizing the research idea, developing products, analyzing data, and writing articles. Agus Kamaludin, a supervisor in research activities to article writing, reviewed and edited.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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