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Augmented reality-based textbook innovation as learning media for learning from home

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Abstract: Since the closure of schools due to the pandemic, Learning from Home *(BDR)* activities have been constrained by the lack of adequate media. This research and development aimed to generate the effectiveness, validity, and Augmented Reality's practicality (AR)-assisted textbooks to be used during BDR for the elementary school level. The development procedure started with a literature study, then continued with planning, expert assessment, preliminary field testing, revisions, and main field testing. The effectiveness of textbooks was determined through field testing, while the validity was determined through expert judgment (experts of material, language, and media). The practicality was determined through the responses of students and teachers. Measurement of the three indicators was carried out in grade IV SDN Jetis Jogopaten and SDN Pandowoharjo. Based on the measurement results, AR-assisted textbooks are included in the "feasible" category. This means that textbooks developed through this research can be used because they meet the eligibility standards according to the expert, are comprehensively responded to by both teachers and students, and are effective in increasing the activity and learning achievement of fourth grade elementary school students. Based on the findings and the evidence above, this study recommends to the teachers and parents to facilitate children with AR-based textbooks as learning media.

Keywords: *augmented reality, learning from home, textbook*

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INTRODUCTION

Covid-19 pandemic pursues the government to shut down schooling activities. Meanwhile, students have to receive their rights in education services. Unesco. UNESCO (2020, p. 1),) stated that more than 190 countries affect Covid-19. Instead of the proceeding constraints , health care, economics, and education have to be fulfilled. WHO, UNICEF, & IFRC (2020, pp. 4–6) in the following matters proposed social distancing, using standardized hygienic sanitation, and even closed the school simultaneously with virus contamination if it didn't meet the preceding requirement. Regarding the phenomena, the teaching and learning process is being conducted online and accommodated through media. In solving the problem, society adapts with the digital transformation working in education. It is considered the safest and effective way to not get contacted with the virus without a student's right dismissal to receiving a proper education.

The Indonesian government through the Ministry of Education and Culture (2020, p. 2) issues a circular No. 15 that the Ministry of Education and Culture is to allow each education

unit to conduct online learning (*daring)* and offline learning (*luring)*, or use both of them. But, in the following practice, most of the education units choose to conduct teaching and learning process online. There are two conditions urging them to have it online. Firstly, not all of the education units and Covid-19 task force allow conventional learning. Secondly, The circular at all once articulates the policy *Belajar dari Rumah (BDR)* or study from home is the best alternative during the pandemic. It is because this policy aimed to fulfill the child's education right, protecting students from the bad effect of Covid-19 and also the spreading of its, and also give psycho-social supports to the teachers, students, and also parents (Kemdikbud, 2020, p. 5).

By means of *BDR*, it can be concluded that the learning today not only could be conducted through conventional interaction but also through online interaction, neither students-teachers nor students. All of the interactants then must adapt with the learning pattern which have never been experienced to. The government must prepare effective and efficient regulation and the teachers must design an active learning activity which is suitable for online learning. While parents must be physically and mentally ready to accompany their children during *BDR,* and students must suit with the following new learning model.

Instead of the following reason, the starting point of online learning (*BDR*) is mostly about the teachers and supporting staff's readiness to conduct teaching and learning process supported by profound designated material (Aldhafeeri & Khan, 2016, p. 204). On that matter, teachers must prepare the learning materials, instead of choosing a compatible learning method and a suitable evaluation tool. The textbook as the main learning material is very important because instead it can be used as the students reference , it also can improve the students' learning achievement in many ways (Behnke, 2018, p. 385). Even according to Miftakhuddin, Mustadi, and Zulfiati. (2019, p. 17), most of the misunderstanding was triggered by the incompatible textbook quality. Practically, the considerably textbook scaffolded will potentially make the learning process more delightful and meaningful. It happens because it directly involves student's cognition through visual information's process, analytical thinking, hypothesis submission along with its evaluation, and also verbal reasoning (Morgan, 2014, p. 73).

In achieving the goals, one text book should be designed systematically and specifically referring to the particular subject and students' progress (Muslich, 2010, p. 50). The arrangement should pivot the dedicated criterion made by curriculum center and Kemdikbud bookkeeping. More than the previous features mentioned, Syamsi, Sari, and Pujiono (2013, p. 84) added the importance of the interest attractiveness in textbooks, so the potency stated by Morgan (2014, p. 73) can be used proportionally. Based on the criteria and the necessity above, it needed to make an interesting and innovative textbook, student oriented, contextual, and compatible with the latest trend of technology advances. Those Four conditions can be fulfilled by augmented reality based textbook development.

AR is the technology that is usually used to convey visual information concretely and contextually through sight sense simulation, therefore the receiving information felt can be as real as the reality (Klimova, Bilyatdinova, & Karsakov, 2018, p. 5). Practically, AR roles as a media to visualizing the abstraction into some tangible thing through three dimension portrayance (Chen ***et al***., 2019, p. 1). If it can be used for education, AR can concrete one the abstract concepts, so that can reduce cognitive burden and it can facilitate teachers who want to create independent learning. That condition happened because AR also facilitates students

to learn using 3D objects, so they can learn the subject using kinesthetic model learning, acknowledging the materials from many perspectives, and enhancing students' understanding through contextual collective information (Diaz, Hincapié, & Moreno, 2015, p. 206).

AR used through smartphones portraying 2D into 3D pictures can attract students' attention to learn more. Instead of the previous statement, 3D visualization picture helps student to comprehend the content served by the teachers, especially for students with low reading skill (Billinghurst & Dünser, 2012, p. 47; Iftene & Trandabăt, 2018, p. 165). Instead of another reason above, this research focuses on text book development as the solution proposed that refers to Ismail ***et al***. (2018, p. 178), stating that AR education can be an innovative approach enabling teachers to use either theory or practice at once. Furthermore, The research of Sirakaya and Çakmak (2017, p. 30) also reveals positive change in students' academic achievement and behavior. Moreover, according Gün and Atasoy (2017, p. 46) the using of AR in education can enhance teachers and students' motivation to conduct simultaneous teaching and learning process

According to the research problem and the research about AR application activity as a learning medium. This research aims to produce a product to solve the problem especially about the deficiency of innovative media learning supporting *BDR*. The product produced can optimize BDR in elementary school.

METHOD

This research was conducted using Research and Development Design. The data gathered by the following steps: collecting the data for pre-research study, planning the research, developing the initial form of the product, initializing field testing, revising the main product, doing main field testing. Those six procedures are the simplifications from ten phases of research and development proposed by Borg and Gall. The research subject was students in 4th Grade in SDN Jetisjogopaten and SDN pandowoharjo. Instead of that, this research also involves researchers and teachers for practicality and validity evaluation.

For the next step of research, data collection obtained through interview, documentation and observation. Interviews were conducted to the teachers teaching grade IV and also their students. The documentation was conducted through textbooks and syllabus. As for observation, it was conducted in the teaching and learning process. The collected information gathered was used for need analysis, in other words, the data collection in this step was used to recognize how urgent the product development needed (Gall, Gall, & Borg, 2003, p. 570). This information later will be used for product development planning.

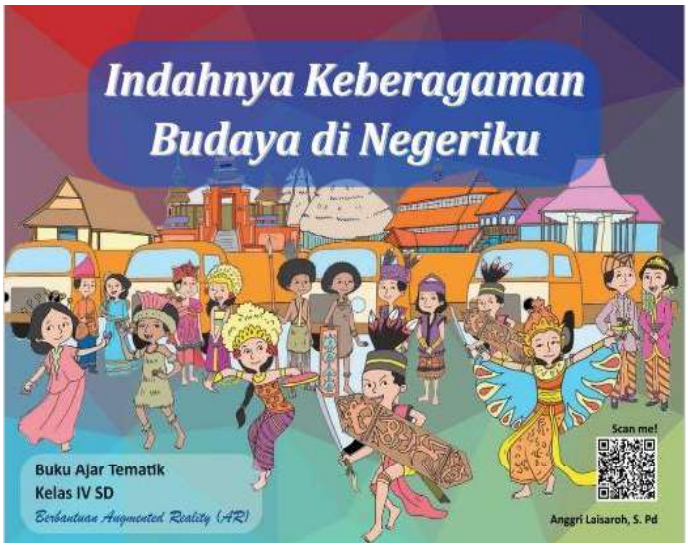
In the planning stage, researchers formulated the goal that they want to achieve. That goal is to develop AR based Textbooks. The following step, in this planning stage is also determined the involved subjects of research and on how they participate in the research (Gall *et al*, 2014, p. 21)

In the initial product's format development, they conducted design development, therefore it resulted in text book design as the archetype to produce textbooks. This stage begins with analyzing the basic competition, indicator and also the goal of learning. preparing evaluation tools based on the product development appropriateness is also involved.

The test result above then was referred to make AR based text book product revision. This refinement is possibly down more than one time. According to the result shown from the initial test. The revision produces a main model that is ready to test more broadly.

In the next stage, the revision result then was tested using greater samples (main field test). This test was conducted by choosing 26 students from elementary school in Pandowoharjo chosen as samples representing students that have low, medium, and high ability. Next, the researchers conducted a learning simulation using the product to the students using teachers helped. In the last stage, a questionnaire was given to the students and teachers. The result of the questioner data than being analyzed and used as the references to revise the product therefore it can be effective and operational product (Figure 1).

Figure 1. Development product



The appropriateness of AR based textbooks began with data tabulation received from the expert evaluation. The quantitative data collected was converted by deciding its range score along with its qualitative criteria. This decision is useful to ease the expert in determining the developments of the product appropriateness. The range score establishment and criteria intended to refer to Table 1. According Table 1, the AR based textbook is stated decent if the analysis results accordingly with the appropriateness aimed for.

Tabel 1. Product appropriateness criteria

Interval	Kriteria
Ri + 1,5 Sdi < Score ≤ Maximum Score Number	Very Appropriate
Ri < score ≤ Ri + 1,5 Sdi	Appropriate
Ri – 1,5 Sdi < skor ≤ Ri	Less Appropriate Layak
Minimum Score Number < skor ≤ Ri – 1,5 Sdi	Not Appropriate

Explanation: Ri: Ideal Average = ½ (Maximum Score + Minimum Score.
Sdi: Ideal Deviation standard = 1/6 (Maximum score + Minimum score).
X: Resulted score.

FINDING AND DISCUSSION

This product developed based on the previous study, planning, and textbook's format development is validated by the expert to rate its validity. There are material, language, and media expertise. The material expertise rated the textbook in the point of view of content completeness and appropriateness according to the basic competence *(KD*), and also according to the understanding competence towards the material. Whilst, the language expert rated the textbook according to the language appropriateness according to the students language development, and also the words appropriateness available in the textbook. While the media expert assessed the appropriateness of the media visualization, accuracy, the portrayance of AR effect, and the usage value of the textbook toward students learning.

Media appropriateness (validity). Based on the evaluation done by the Material expert, AR based textbook is stated appropriate to be used. That thing is based on two aspects that each of those is stated appropriate. For the Completeness of the content and KD's appropriateness, the rate is 24, whilst the evaluation Appropriateness of the concept towards the material' rate is 17. Even the material expert stated that this textbook is appropriate to be used, but the material expert proposed some refinement. It means according to the material expert, the AR based textbook is worth to be used after undergoing the experts revision.

Different with the appropriateness in material content, AR based textbooks are worth to be viewed from the language used. This conclusion is based on the given score from the language expert. The score of the language appropriateness is 24 (very appropriate), while the Glosarium score is 11 (very appropriate). But, as the material expert, instead of giving a score, the language expert also proposed some recommendations for the textbook improvement. So, AR based textbooks can be worth using after some improvement given from the language expert.

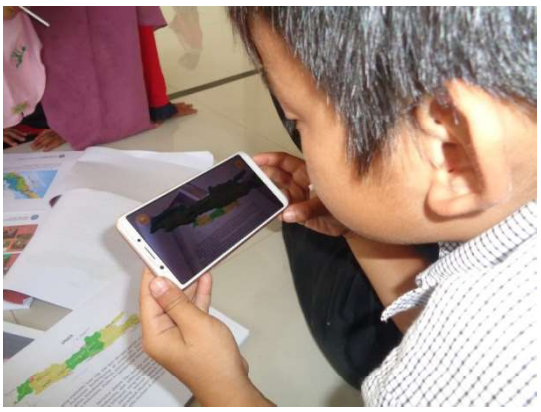
Similar to the material expert expertise, the appropriate AR based textbook as the learning media is rated worthy. As the language and the material expert, the media expert instead of giving evaluation, he/she also proposed some recommendations for product improvement. The conclusion about this appropriateness is received based on the evaluation viewed from an appearance aspect which is given score 33 (appropriate), also the evaluation form the accuracy usage aspect, AR effect simultaneously got score 11 (appropriate), 10 (appropriate), and 9 (less appropriate). According to the media expert evaluation, the developed textbook viewed from AR effect is assumed less appropriate. But, by giving some improvement for the AR effect aspect, overall the Media experts stated that the developed textbook is appropriate to be used in the learning process.

According to the Material, language, and media experts, AR based textbooks developed in this research can be stated appropriate to be used in the learning process. As for the students and teachers responding after the field test (Figure 2), results have been explained and interpreted in these paragraphs below.

Media practicality and effectivity. In the initial test towards the students sample (n=6), 16,6% students rated that AR based textbook is very appropriate, meanwhile 83,4% rates that it is appropriate. It means that during the learning process, the AR based textbook usage helps the student to comprehend the learning material more than before.

According to Majid, Mohammed, and Sulaiman (2015, p. 111), the students felt to be assisted as revealed by the evaluation test above because AR is interactive. It can attract students' attention through its advantages in visualizing information into 3D objects. That

Figure 2. Initial field trial test



attraction and the features which finally make the learning situation become comfortable, interesting, and pleasant. These advantages is also able to tackle elementary school students difficulties in comprehending all of the abstraction as stated by Retnawati, Kartowagiran, Hadi, & Hidayati (2011, p. 162)

The result of the analysis in this in experiment stage actually have confirmed the finding of the experiment conducted by Khan, Johnston, and Ophoff (2019, p. 1), instead improving students satisfaction in learning, AR usage also affects to the students convenience in studying. The improvements are always received by using PowerPoint. It happens because Power doesn't provide an augmentation feature (Zhang, Yen, Liu, Sung, & Chang, 2020, p. 1). Therefore, The AR usage can overcome Power Point weakness by integrating augmented effect in the conveyance communicated by the teachers, either audially or visually.

Through this way, students finally can easily connect the real experience with their preceding knowledge. It means that AR usage in learning is not only able to improve students' academic skills but also can change student behavior in the real situation to do non-formal learning activity consistently (Hwang, , Wu, Chen, & Tu, 2016, p. 1).

Different from the students evaluation as have been discussed above, the teachers evaluation collected through respond's questioner shows that AR based textbook is in a very appropriate category viewed from its' language appropriateness. For the initial trials, the text book is in very appropriate category measured from language appropriateness scored 15, material appropriateness scored 30, and its usage scored 10

Instead of using response questionnaires, teacher perception picture towards AR usage in learning, we also can see their enthusiasm during the learning process-observation, or from their interest about AR initialized with their download activities and AR based textbook creation (Mundy, Hernandez, & Green, 2019, p. 1). This research uses a response questionnaire because its initial text goals are not only to reveal practical aspects, but also to collect suggestions or teachers recommendations . This goal only can be achieved effectively by using a response questionnaire.

Even though the evaluation result has confirmed all of the research findings above, the product development stage is continued into a prior revision and evaluation using a lot of test subjects. As the stages needed along with development products, this stage is also

meant to strengthen textbook practicality and enlarges the possibility of the research result to generalize.

According to the AR textbook's initial test was revised, then it would be tested in a prior field test in SDN Pandowoharjo. This test has the same goal with the preceding initial field test. Different from the prior stage, this stage used more samples (n=15). According to the test result, 66% of students rate the revised textbook as very appropriate. And the rest of them 34% rates appropriate.

The comparison between initial test result and prior test shows the subjects test 's evaluation improvement. It means that the improvement revision of the development product gives significant effect to the students' satisfaction, motivation, attention and comfort in learning process. So, it can be concluded that an AR based textbook is appropriate to be used regarding its practicality.

According to the main field test, it can be concluded the text book developed is still categorized appropriate. Only , in the evaluation result, there is an improvement in its score regarding to the material appropriateness which is scored 31 and the usage aspect which is scored 12.

The main field test above shows the priority evaluation's improvement, either shown by teachers and students. This means that the revision and the improvement of the textbook conducted works significantly. Instead, according to the recorded comment in the questionnaire, it is found that the students are very enthusiastic to learn every material. This interest is caused by 3D visualization enabling the students to get concrete 2D portrayment in textbooks. According to their acknowledgement, the visualization enables them to comprehend the given material easily, instead of increasing their motivation to search new information in textbooks independently.

AR based textbook development is one of the innovations aiming at 4th Grade elementary school students. After undergoing expert evaluation, revision, and twice trial text, it is concluded that AR based textbooks are worth using on a large scale. More than that, this book is ideal to support students in learning during BDR because instead of being interesting, AR based textbooks can manifest the abstraction into concrete things so it reduces students 'cognitive burden, and roles as the media to create independent learning.

The preceding statement is relevant to the researchers experience in doing BDR, there are some barriers that obstruct like: the students difficulty to comprehend the material because they don't have an effective learning media, students low motivation to learn, ineffective interaction between teachers and students, as the result it affects negatively to the students achievement. Practically, students are unable to achieve academic improvement even after they have undergone daily-basis learning. this problem is known as learning loss (Di Pietro, Biagi, Costa, Karpiński, & Mazza, 2020; Kuhfeld et al., 2020, p. 550).

Theoretically, this problem happened because BDR is more like homework, than home-learning. This case happened in Deveci (2019, p. 57), which proved about teachers' tendency to misinterpret it as a working home used as an alternative to support students to get more information that can be received at school. The students given assignments usually are irrelevant and are not representative with their needs.

The experiment conducted by Deveci (2019, p. 57) affirmed that home-learning is better than homework, at least it is viewed from the learning material and students' need in the following future. The BDR concept that has been mentioned in the preceding sentence has

duplicated the home-learning concept correctly, a thing that differentiates only the textbook. That problem initiates more barriers in a teaching and learning process. Relating to the textbook stagnancy's previous problem, the conducted research proves that the previous instructional problems can be tackled by using AR based augmented reality.

The further analysis in the research shows that there are two advantages for the AR based Textbook. *First*, because the elementary school students have tendency to get interested with something new, therefore the using AR based textbook that is rarely used by the students can enhance students learning motivations as have been described in many research that learning motivation improvement is in line with learning intensity, enthusiasm, and at the top of the stages it can improve students capacity to process the information.

Second, the ability of AR based textbooks can decrease the information standard that is difficult to comprehend by the students. It enables the students to choose which information they want to process actively, ironically and symbolically. Jerome Bruner has discussed this ability stage of processing information. According to him, the students individually that have been into this stage tend to use symbolic ways of thinking. He/she can accept, produce, and interpret one of the information received only based on one verbal symbolization, and another language signs.

For the student with under average thinking ability, he/she tend to use iconic thinking ability. There are some students who are in this cognitive stage tend to use icon or picture, so it is can be assured that some students still to think actively. Students still need real things or direct experience so he/she can accept, process, and interpret the information.

The augmented information technology in the textbook developing in this research enables the students to have individual learning according to their cognitive ability. If students reach the ability to think symbolically, therefore they do not need 3D visualization. It is needed only to portray new information that the students experience in the real world. Whilst, for the students that still think iconically and actively, 3D visualization in this textbook helps to manifest the abstract thing concretely into 3D modeling resembling the real figures.

Thereby as an AR based on textbook, This textbook in this research is able to manifest the abstraction of the concept into real thing, therefore the object dimension resembles the real thing (3D). It gives clear vision about one object because it is manifested visually by triggering the other human sense instead (Klimova et al., 2018, p. 5).

Media novelty. Theoretically, the advantages can be achieved maximally by the samples (grade 4th elementary school students) because this AR advantage is suitable with the students cognitive development. This assumption according to Nugroho, Hartono, and Sudiyanto (2020, p. 15) that stated about student learning needs in elementary school. They stated that there is insufficient textbook and media that is able to convert the abstraction into concrete things. They suggest a development program to solve that problem.

As through following their recommendation, the text book in this research fulfills that instructional needs. In other words, the AR technology used in the textbook relies on the abstraction conversion into the real concrete thing contextually, while the students cognitive development is in that concrete operational stage (Babakr, Mohamedamin, & Kakamad, 2019, p. 519).

In this cognitive development, students can easily understand something that they saw concretely (something touchable & sensible). Vice versa they will have difficulties about one concept abstractly, more over something that relates to someone's empathy, emotion, and psychologic condition (Miftakhuddin, 2018, p. 104).

Because of that, the learning activity must be conducted contextually, so the students can connect the learning material learned at school with their experience that they have on their daily basis activities (Mana, Yusandra, Atmazaki, & Ramadhan, 2020, p. 154). relating to the ideal learning target. AR based textbooks developed in this research are determined to manifest abstract conception into something that has dimension. As being elaborated in this course talking about experience cones proposed by Edgar Dale, that student comprehends 10% of the learning material by doing reading. But, they get more than 30% of the learning knowledge with visual learning. And even they will get 50% of the learning knowledge if they experience both (Davis & Summers, 2015, p. 2). Inilah yang oleh Klimova et al. (2018, p. 5) stated it as the advantage of AR that is able to portray the object comprehensively, because it stimulates more than one senses.

It is different from the other research that gives a trial to a product in a university, this research develops a product for elementary school students, therefore the resulting product's effectiveness will be more solutive. It happens because students have limited ability to interpret the verbal information received (Pexman & Glenwright, 2007, p. 179). This interpreting limitation that will be handled by AR usage in teaching and learning situations (Safar & Al-Jafar, 2017, pp. 418-419).

In this cognitive development, students can easily understand something that they saw concretely (something touchable & sensible). Vice versa they will have difficulties about one concept abstractly, more over something that relates to someone's empathy, emotion, and psychologic condition .

Based on the preceding research above, Zhang, Ogan, Liu, Sung, and Chang (2016, p. 107) stated that a lot of AR usage in learning activity indeed advantaged the students to improve their academic achievement as has been proved in this research. AR supports pedagogic and instructional processes massively.

The research finding enhances another research that also discusses the textbook and learning development along with experiments worked in elementary school students (Yamtinah, Roemintoyo, & Kartikasari, 2020; Avikasari, Rukayah, & Indriayu, 2018). But, Tzima, Styliaras, and Bassounas (2019, p. 1) opposed the preceding finding. She tried to identify the students' experience of AR Usage. The result states that AR is worth to be used in learning activity only if it fulfills the requirements. Those criteria can be technical (gadgets availability as the supported tools), or psychological features

It means the AR usage expected as the real solution for most of the instructional problem, is still left an thorough irresolute inclusivity problem. Particularly in marginal Indonesian schools. The AR based textbook usage is an exclusive facility with uneven possession. Instead of using the textbook, the students can afford to get the AR or can operate it accordingly.

Even though the student is able to provide the AR facilities, they probably don't have the cognitive ability to operate them (Rana, Rajiv, & Lal, 2014, p. 22). So, Zhang, Ogan et al. (2016, p. 107) gave important notification pertaining to the appropriateness The AR usage with the students characteristic. Their research then reveals the most suitable students that able to use AR are the students who have kinesthetic learning modality. As for student who has visual learning modality, according to Chandrasekera & Yoon (2018, pp. 55-56) will be in the second position for the effectivity possession of AR based textbook's ability.

Furthermore, Chandrasekera & Yoon (2018, pp. 55-56) described that the students with kinesthetic modality tend to receive the AR learning material effectively. This happens

because they have higher motivation toward tactility forms. Meanwhile, the with Students with visual modality have the same category with the previous one. This happens because they have high motivation towards tactility. Vice versa with the previous characteristic, the students with audio ability have less motivation, so this AR usage is less effective than the students with visual. This happened because the learning' audio' is less dominant than its AR feature so the student is then least motivated in learning using an AR textbook. Furthermore, it also happens to the students who have read/write modality.

Therefore, as the statement initialized in the beginning of the paper, the AR usage in education should have directed to conduct individual learning. if AR will be used for classical learning, therefore it need further development so it will be more attracts the students with aural and read/write modality characteristic. It happens sometimes that the media or textbook development is needed to accommodate students with aural and read/write modality so it can tackle the disparity with the two previous modality. Furthermore, the students with that modality can be equal with the students who have visual modality in comprehending the material (Risnawati, Amir, & Sari, 2018, pp. 1-2).

AR development also considers student's social and psychological effects. The consideration is very important to be recognized because according to Savela, Oksanen, Kaakinen, Noreikis, and Xiao (2020, pp. 6-7), AR usage does not significantly affect the students' social ability. Bistaman, Idrus, and Rashid (2018, p. 1), stated that AR usage can reduce a student's collaborative ability. Those statements oppose the current education trend that more supports collaboration rather than competition. These issues furthermore can be researched for the further following research.

CONCLUSION

BDR implementation during Covid-19 has some barriers. Those include: Students' difficulty to comprehend the material because of the insufficient learning media, student's low motivation, ineffective interaction between the teachers and the students that affects student achievement's reduction.

AR based textbooks developed in this research are effective to reduce the problem mentioned above. This claim is based on the expert evaluation, field trial text, and also the response of the research samples which is accommodated and analyzed in a series of research developments. Based on the previous analysis, and some relevant research comparison conducted, it can be concluded that the AR based textbook developed in this research has been into improvisation and this research is worthy appropriate in supporting student individual academic learning, particularly for 4th grade students during the *BDR*.

However, based on this research it needs to be articulated that the pattern change in online learning including *BDR* can occur easily based on the situation happening in the elementary school. If there is an online shifting pattern again, as stated by Dang (2017, pp. 2-3), it will also enforce the teacher to adapt with the shifting. The adaptation mentioned above includes pedagogic competence, and technology competence.

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