Integrating Augmented Reality into Worksheets: Unveil Learning to Exercise Higher-Order Thinking Skills  
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Fauzi Bakri1, a) and Author’s Name2, 3, b)   
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Author Affiliations

1Physics Education Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jakarta, 13220, Indonesia

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b)anotherauthor@thisaddress.yyy  
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**Exp:** Learning in the 21st century has encouraged the presence of technology in education. Physics is one of the subjects that require a practicum to deliver abstract material. However, in the current physics practicum, student worksheet is still being used which does not support high-level thinking skills and technology is not yet integrated. This study aims to produce practical worksheet equipped with augmented reality (AR) in physics material. This study uses the research and development method of the Dick and Carey model. The data of this study were obtained from the results of validation by experts in the material, media, and learning, as well as the results of trials by teachers and students conducted with a Likert scale questionnaire. A pretest and posttest are also conducted to test the improvement of students. The product produced is worksheet equipped with AR technology that can display videos at stimulus stages, procedures, and conceptual applications by scanning images bearing the AR logo with an android smartphone. The results of the worksheet feasibility test conducted by material experts received an average percentage of 93%, the feasibility test conducted by media experts obtained an average percentage of 90%, and the feasibility test conducted by learning experts received an average percentage of 81%. The results of user trials by teachers get an average percentage of 98%, user trials by students get an average of 90.1%, and the results of pretest and posttest get N-gain of 0.72. This study indicates that the Worksheet for Students to practice higher-order thinking skills has met the criteria very well based on the assessment in terms of material, media and learning and declared fit as Physics teaching materials in class material XII Odd semester.

# first, second, and third level headings (first level heading) (Use the Microsoft Word template style: *Heading 1*) or (Use Times New Roman Font: 12 pt, Bold, ALL CAPS, Centered)

Example:

# introduction

The 21st-century technological advances have entered various aspects of life, including education [1,2]. Many developing technologies complement each other in designing more productive, and efficient education in 21st-century technological advances has entered various aspects of life, including education [3]. The 21st Century learning requires students to have skills, knowledge, and abilities in the fields of technology, media and information, as well as learning skills, innovation, life skills and careers [4,1]. The 21st-century knowledge is qualitatively different from 19th and 20th-century knowledge, so it is necessary to consider how that knowledge can be learned and accessed through digital technology design [5]. In the context of learning, students must also learn the essential skills to succeed in today's world. These skills include critical thinking, problem-solving, communication, and collaboration [4].

# Method

Research and development methods are studies that examine theories, concepts, or models to create new products or enhance existing products. This research and development are following scientific rules. This research and development can be carried out in various fields, one of which is in the field of education [31]. This model is seen as the organization and the process of providing a series of information, examples, experiences, and activities that guide, support, and improve the internal mental processes of students [32].

# result and discussION

The resulting student worksheet contained several images which were used as markers. These markers will be integrated with the AR application, which is displayed in the form of video. This information can be presented with the help of an application installed on an Android smartphone that has been developed with the appearance shown in Fig. 4. (a). Appearance (b) on the menu, (c) in the chapter, and (d) information about the application. The way to use this media is to point the Android smartphone camera that has been integrated with the AR application to the marker contained in the student worksheet. Furthermore, the camera will display virtual information in the form of videos about practical instructions. The camera is used offline, so it does not require an internet network.

|  |  |
| --- | --- |
|  |  |
| (a) | (b) |
|  |  |
| (c) | (d) |

**FIGURE 4.** Interface of Augmented Reality Applications.

## Formative Evaluation Test Results

The results of the development of this worksheet have passed the material validation test, media validation, learning validation and user test by the teacher. The following Table 1 is the result of the validation of AR students worksheets.

**Table 1.** The Validation Results of Student Worksheet

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Aspects Measured** | **Presentation Scale** | **Interpretation** |
| Material Expert Validation | | | |
| 1 | Material conformity | 96.36% | Very Good |
| 2 | Writing Language | 95% | Very Good |
| Average of all aspects | | 95.68% | Very Good |
| Material Expert Validation | | | |
| 1 | Didactical requirements | 80% | Very Good |
| 2 | Construction requirements | 83% | Very Good |
| 3 | Technical requirements | 80% | Very Good |
| 4 | HOTS | 80% | Very Good |
| Average of all aspects | | 81% | Very Good |
| Teacher Field Test | | | |
| 1 | Conformity of Material | 100% | Very Good |
| 2 | Appearance and Typography | 100% | Very Good |
| 3 | Language Suitability | 95% | Very Good |
| 4 | *Augmented Reality* | 97% | Very Good |
| Average of all aspects | | 98% | Very Good |

The results of the material feasibility test results obtained assessment results that are 95.68% with the interpretation of "very good" shown in Table 1. The advice is given; namely, the use of quotations can be translated into Indonesian, and corrections by providing information on questions that have errors.

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# mathematics (first level heading) (Use the Microsoft Word template style: *Heading 1*) or (Use Times New Roman Font: 12 pt, Bold, ALL CAPS, Centered)

Here we provide some basic advice for formatting your mathematics, but we do not attempt to define detailed styles or specifications for mathematical typesetting. You should use the standard styles, symbols, and conventions for the field/discipline you are writing about.

## A Note on Microsoft Word’s Equation Editors (Second Level Heading) (Use the Microsoft Word template style: *Heading 2*) or (Use Times New Roman Font: 12 pt, Bold, Centered)

From Word 2007 onwards, Microsoft Word provides two “Equation Editors,” which, for ease of reference, we’ll call “Old Style Equations” and “New Style Equations.”

* **“New Style Equations”** (Word 2007 onwards): With Word 2007 Microsoft introduced a powerful new built-in Equation Editor that enables input of sophisticated mathematics typeset (usually) in the Cambria Math font. You access it from the Insert menu.
* **“Old Style Equations”** (Word 97–Word 2003): For versions of Microsoft Word between Word 97 and Word 2003, mathematical input was created by an add-in: Inserting and editing a “Microsoft Equation 3.0 object,” typically by *Insert* ð *Object* and selecting “Microsoft Equation 3.0.”

Newer versions of Microsoft Word (Word 2007 and onwards) still support the original “Old Style Equations” method of creating mathematics by inserting an equation via *Insert* ð *Object* and selecting “Microsoft Equation 3.0.” Whatever method is used, please make sure the equation is clear and readable.

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Due to technical requirements of OpenType font technology, Microsoft Word’s “New Style” Equation Editor works only with fonts specially designed for mathematical typesetting. Unless you have obtained and configured new OpenType math fonts, it is highly likely that your installation of Word will use the Cambria Math font for all mathematics created with the “New Style” editor. Using the Cambria Math font for mathematics and Times Roman for your text will cause a mismatch in the visual appearance of your article, so, for consistency, we prefer authors to use the “Old Style” Equation Editor because it is straightforward to amend the size/style of the fonts it uses.

## Formatting and Inserting Equations (Second Level Heading) (Use the Microsoft Word template style: *Heading 2*) or (Use Times New Roman Font: 12 pt, Bold, Centered)

Equations should be centered with equation numbers on the right-hand side (flush right). Achieving a pleasing layout of equations can be tricky in Microsoft Word, so here are some tips. You can either:

1. Copy, paste, and edit the sample equation provided (recommended), or
2. Manually insert an equation and equation number

### Copy, Paste, and Edit a Sample Equation (Third Level Heading) (Use the Microsoft Word template style: Heading 3) or (Use Times New Roman Font: 10 pt, Italic, Centered)

To use this “Old Style Equation” as a “template,” highlight the entire line, then use cut and paste to the new location. Note that the equation number will automatically update (increment).



### Manually Inserting an Equation and Equation Number (Third Level Heading) (Use the Microsoft Word template style: Heading 3) or (Use Times New Roman Font: 10 pt, Italic, Centered)

If you prefer to manually insert and number equations, follow this step-by-step guide:

1. Make sure you can see “hidden characters” by switching on “show invisibles” from the Home menu (it looks like this: ). This allows you to see paragraph markers (¶) and tab characters (à), which are usually hidden from view.
2. Create a blank paragraph by pressing [ENTER].
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4. Place your cursor at the start of your new paragraph and press the [TAB] key twice.
5. Place your cursor between the tab characters (à) and insert your equation using *Insert* ð *Object* ð *Microsoft Equation 3.0*.
6. To add an equation number, place your cursor at the end of the paragraph (just before the paragraph markers (¶) and after the second tab character (à)).
7. On the *Insert* tab, in the *Text* group, click *Quick Parts* and then click *Field*:



1. A dialog box should appear:



1. From the list of *Field Names* on the left of the dialog box, select *ListNum.*
2. From the list of *Field properties* on the right, select the “Equations” *List name* and click OK. You should now see an equation number in parentheses: e.g., (3).

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|  |  |
| --- | --- |
|  |  |
| (a) | (b) |

**Figure 1.** To format a figure caption, use the Microsoft Word template style: *Figure Caption or Times New Roman Font: 9 pt, Centered*. The text “**FIGURE 1,**” which labels the caption, should be bold and in upper case. If figures have more than one part, each part should be labeled (a), (b), etc. Using a table, as in the above example, helps you control the layout

Cite all figures in the text in consecutive order. The word “Figure” should be spelled out if it is the first word of the sentence and abbreviated as “Fig.” elsewhere in the text. Place the figures as close as possible to their first mention in the text at the top or bottom of the page with the figure caption positioned below, all centered. Figures must be inserted in the text and may not follow the Reference section.

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Due to the wide range and complexity of tables, we simply offer an example for guidance. Please follow the style for table (and figure) captions.

|  |  |  |
| --- | --- | --- |
| **TABLE 1.** To format a table caption, use the Microsoft Word template style: *Table Caption*. The text  “**TABLE 1,**” which labels the caption, should be bold and all letters capitalized. Center this text above the Table. Tables should have top and bottom rules, and a rule separating the column heads from the rest of the table only. | | |
| **Column Header Goes Here** | **Column Header Goes Here** | **Column Header Goes Here** |
| Row Name Here | x | x |
| Row Name Here | x | x |
| Row Name Here | x | x |

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# Acknowledgment

We acknowledge to the head of the Physics Laboratory at Universitas Negeri Jakarta. This research was developed in the Modern Physics Laboratory and Digital Laboratory - Physical Education Program, Universitas Negeri Jakarta.

If desired, in this section we welcome you to include thank your comments for those who have supported your research. Font should be Times New Roman, 10 pt.

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# References

1. UCLES, Global Education Census Report, Cambridge Assessment International Education, Cambridge (2018).
2. W. Dick and L. Carey, The Systematic Desigh of Instruction, Pearson Education, New York (2015).
3. J. W. M. Lai and M. Bower, *Comput. Educ.* ***133***, pp. 27-42 (2019).
4. H. E. Vidergor, M. Givon, E. Mendel, *Think. Ski. Creat* ***31****,* pp. 19-30 (2018).
5. E. M. Janssen, *Teach. Teach. Educ.* ***84***, pp. 139–149 (2019).
6. F. Bakri, D. Ambarwulan, D*.* Muliyati, *J. Ilm. Penelit. dan Pembelajaran Fis.* ***4 (2)***, pp. 46–56 (2018).
7. A. H. Permana, D. Muliyati, F. Bakri, B. P. Dewi, D. Ambarwulan, *J. Phys. Conf. Ser.,* 1157(3), pp 032027 (2019).

References should be numbered using Arabic numerals followed by a period (.) as shown below and should follow the format in the below examples.

1. M. P. Brown and K. Austin, *The New Physique* (Publisher Name, Publisher City, 2005), pp. 25–30.
2. M. P. Brown and K. Austin, Appl. Phys. Letters **85**, 2503–2504 (2004).
3. R. T. Wang, “Title of Chapter,” in *Classic Physiques*, edited by R. B. Hamil (Publisher Name, Publisher City, 1999), pp. 212–213.
4. C. D. Smith and E. F. Jones, “Load-cycling in cubic press,” in *Shock Compression of Condensed Matter-2001*, AIP Conference Proceedings 620, edited by M. D. Furnish *et al*. (AIP Publishing, Melville, NY, 2002), pp. 651–654.
5. B. R. Jackson and T. Pitman, U.S. Patent No. 6,345,224 (8 July 2004)
6. D. L. Davids, “Recovery effects in binary aluminum alloys,” Ph.D. thesis, Harvard University, 1998.
7. R. C. Mikkelson (private communication).

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