

Development of a Game-Based Test Instrument Using RPG Maker MZ Software on Exponential Functional Materials

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Abstract: This study aims to produce a game using software RPG Maker on valid, practical and reliable exponential function material. The type of research used is Research and Development with the ADDIE model. The product in this study was tested on class X students at SMK PGRI 2 Palembang in the even semester of the 2021/2022 academic year. With data collection techniques, namely interviews, validation questionnaires, student response questionnaires, and test questions. Product validity was seen from the validation questionnaire by three validators and obtained a score of 81.90% with a very valid category. The practicality of the product was seen from the student response questionnaire and obtained a score of 80.33% in the very practical category. Reliability is seen from the test results and obtained a reliability score of 0.608 with a high reliability category.

Keywords: Game Based Test, Software RPG Maker MZ, ADDIE model, exponential function

1. INTRODUCTION

The test instrument is a measuring tool used to collect and manage information and data to see the success of students in mastering learning outcomes [1]. In the era of the industrial revolution 4.0, tests are not only carried out via paper that is given directly, but such also as government products related to the Computer-Based National Assessment (ANBK) which will begin to be used in 2021 [2]. Tests using paper require a lot of equipment, educators also need time to correct students' answers and there are still many students who cheat so that educators do not understand real abilities and what material these students do not understand [3]. The development of technology-based test instruments is still very rare because educators' understanding of problem development using technology is still lacking. The positive impact of technology is the creation of various IT-based learning media that can assist in the learning process [4]. Making test instruments can also be developed in the form of games [2].

Games have the ability to encourage students' interest in learning, practice problem-solving skills, and learning using games can also increase perseverance, flexibility, curiosity, self-confidence, tenacity and patterns of thinking in math instruments [5]. The impact of games is that they forget to learn, so games that are made must consider various things so that games can educate, increase knowledge, improve skills and increase students' learning motivation [6]. Now there are many kinds of games played by students, several types of games themselves including Action, Adventure, Fighting, Racing, RPG, Shooter, Sport, Strategy, Board game/Card game, Music Game [7]. The survey results from Agate Studio show that out of 1200 gamers in Indonesia, 46% like RPG type games [8]. There are many kinds of software used to develop RPG-type games, one of which is RPG Maker [9].

In RPG Maker there are calculation parameters, game actor class settings, logic and algorithms for plotting per scene, animations and magic effects that support game creation [10]. The application used by researchers to make games is RPG Maker MZ, which is the game engine of the RPG Maker series, which was released on August 20 2020. RPG Maker MZ is an

application developed by Enterbrain and can be used to make Role Playing Games properly. RPG Maker MZ can be developed in the form of a smartphone application [11]. In December 2021, 59.22% of smartphone users in Indonesia used the Android operating system, 5.68% used the iOS operating system, and 29.09% used the Windows operating system [12]. The operating system can be described as a connecting device so that the products that have been created can be run by students [11].

This research is relevant to research conducted by [2], with the title design of a game-based mathematical problem-solving ability test instrument. However, research conducted by [2] uses the unity application, while in this study it uses the RPG Maker MZ application, both of which are game-making applications. In addition, the research conducted by [2] contains all mathematical material, whereas in this study only material for exponential functions is specific. The method used by [2] uses the R&D method with the ADDIE model, the same as this study. However, in [2] it only reached the design stage, whereas in this study it will be completed until the evaluation stage.

Based on the description of the problems above, this study aims to produce a product in the form of a game-based test instrument on exponential function material that can increase the attractiveness of students in working on practice questions, improve conceptual understanding and problem solving, increase the value of student learning outcomes and test instruments that suitable for use as a test tool that meets the criteria of valid, practical and reliable.

2. RESEACH METHODOLOGY

The method in this research is research and development. The research and development procedure used in this research is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). This research was conducted at SMK PGRI 2 Palembang in the even semester of the 2021/2022 academic year. The data collection method used was interviews used to see product legibility, validation questionnaires were used to see product validity, student response questionnaires were used to see product practicality

and tests were used to determine validity, reliability, distinguishing power and item difficulty level.

1. Validity Analysis Techniques

Product validity was measured based on the results of a validation questionnaire which was validated by 3 validators. This questionnaire was made using a Likert scale from 1 to 5 for very good, good, moderate, poor, and very poor answers. analyzed by calculating the average answer based on the score of each answer from the expert with the following formula:

$$\text{Percentage} = \frac{\text{raw score}}{\text{maximum score}} \times 100\%$$

Furthermore, the percentage validity of the experts obtained is interpreted into validity criteria. The validity criteria by experts can be seen in the following table:

Table 1. Validity Criteria

Percentage Score (%)	Interpretation
0% - 20%	Very invalid
21% - 40%	Less valid
41% - 60%	Quite valid
61% - 80%	Valid
81% - 100%	Very valid

Source: [13]

The developed test instrument is said to be valid if the minimum percentage of validity reaches 61%.

2. Practicality Analysis Techniques

Based on the assessment response data from the implementation stage by students, it can be analyzed to see the practicality of the product. The student response sheet is a questionnaire that contains questions about the ease of use of the created game-based test instrument. To calculate the average score of student response questionnaires, the formula is used:

$$\text{Percentage} = \frac{\text{raw score}}{\text{maximum score}} \times 100\%$$

The results of these calculations are interpreted into practical criteria which can be seen in the following table:

Table 2. Practicality Criteria

Percentage Score (%)	Interpretation
80% - 100%	Very practical
60% - 80%	Practical
40% - 60%	Adequate
20% - 40%	Less practical
0% - 20%	Very impractical

Source: [14]

Based on the table above, a game-based test instrument can be said to be practical if it obtains a minimum percentage score of 60%.

3. Item Validity Test Techniques

The game-based test instrument on exponential function material that was tested at the field test stage was to see its empirical validity. The technique used to test the validity of the test questions is the product moment correlation technique proposed by Pearson (Arikunto, 2018).

$$r_{xy} = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{\{N \sum X^2 - (\sum X)^2\}\{N \sum Y^2 - (\sum Y)^2\}}}$$

Description:

r_{xy} = correlation coefficient between variable and variable, the two variables are correlated

N = Number of students

x = Scores of all students for each item

y = Scores of all students

The formula above is to find the validity of the questions as a whole test. The question is said to be valid if the calculated r value $> r$ table.

Table 3. Question Validity Criteria

Hasil r_{xy}	Interpretation
0.801 - 1.00	Very high
0.601 - 0.800	High
0.401 - 0.600	Sufficient
0.201 - 0.400	Low
0.00 - 0.200	Very Low

Source: [15]

4. Item Reliability Test Techniques

A test instrument will be reliable if the estimates are consistent or fixed. The purpose of holding a reliability test is to determine the consistency of the test equipment as a measuring tool so that the results can be trusted. The problem is said to be reliable if the calculated r value $> r$ table. For benchmarks the degree of reliability of the test used is as follows:

Table 4. Degree of Reliability

Interval	Interpretation
$0 < r_{11} \leq 0.200$	Very low reliability
$0.200 < r_{11} \leq 0.400$	Low reliability
$0.400 < r_{11} \leq 0.600$	Moderate reliability
$0.600 < r_{11} \leq 0.800$	High reliability
$0.800 < r_{11} \leq 1.00$	Very high reliability

Source: [15]

5. Difficulty Level Test Technique

The criterion used is the smaller the index obtained, the more difficult the test. Meanwhile, the greater the index obtained, the easier the test. The following table shows the difficulty index criteria:

Table 5. Difficulty Index Criteria

Difficulty Index	Difficulty Level Category
0 - 0.30	Difficult
0.31 - 0.70	Moderate
0.71 - 1.00	Easy

Source: [15]

Based on the criteria above, if students can work on the questions and get ≤ 0.30 it is categorized as difficult so the test questions are discarded. If you get an equals to 1 score, it is categorized as easy, so the test questions are still used or discarded according to their use.

6. Distinguishing Power Testing Technique

According to Arifin (2017), discriminating power is an estimate of the extent to which a test can identify students who have mastered the material and those who have not mastered the material. The formula used to calculate the discriminating power of the items is:

$$D = \frac{B_A}{J_A} - \frac{B_B}{J_B}$$

Description:

D = distinct power

B_A = The number of participants in the upper group who answered the questions correctly

B_B = The number of participants in the lower group who answered the questions correctly

J_A = The number of participants in the upper group

J_B = The number of participants in the lower group

Table 6. Distinct Power Criteria

Difficulty Index	Difficulty Level Category
0 - 0.20	Bad
0.21 - 0.40	Adequate
0.41 - 0.70	Good
0.71 - 1.00	Excellent

Source: [15]

3. RESULT AND DISCUSSION

3.1 Analysis

At the analysis stage, the researcher carried out a needs analysis and curriculum analysis. In the needs analysis, the researcher conducted a problem analysis by means of a literature study by reviewing journals about the need for game-based test instrument development. In the curriculum analysis the researcher determines the Basic Competency (KD) and Competency Achievement Indicators used.

3.2 Design

At the design stage, what the researchers did in designing the exponential function test instrument were: (a) Making a test grid of exponential function material according to KD and indicators at the curriculum analysis stage, and (b) Making question cards and answer keys on exponential function material. So that the resulting problem consists of 25 exponential function test questions.




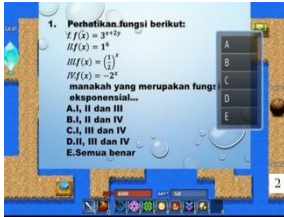

After the question creation process is complete, the next step is to create media or test kits using the RPG Maker MZ software. Before starting to design, the researcher made a game title that will be displayed at the beginning of the game, namely Exponential Function Problem Exploration. Activities in making media are (1) designing game intros, (2) designing game maps, (3) designing game characters, and (4) designing game events. The results of making the first game-based test instrument design are called prototype 1.

3.3 Development

The development stage consists of two stages, namely the validation stage and one to one trials. Validation was carried out on three validators to see validity and one to one trials were carried out on three students to see readability.

The prototype 1 validation stage still contains suggestions and comments from the validator which must be revised in order to produce a feasible product. The results of suggestions and comments from the validator on prototype 1 are presented in the following table.

Table 7. Validity Criteria

Before	After
Plants in the second location closer to the house. 	
The third location for placing the questions is too far away so it is not clear which way to look for questions. 	
The background questions in the game are all made uniform using a background, preferably using a colored background. 	
Instructions for playing the game are made 	

After going through the validation stage on prototype 1, it was revised to become prototype 2. Prototype 2 was then re-assessed by the validator and declared feasible to be tested at the next stage.

In the one-to-one trial phase, the researcher interviewed the three students to see the legibility of the game-based test instrument. Based on the results of the interviews, there were a number of questions that were too difficult and required a long time to calculate the answers, so the questions were corrected and reduced. Then the number of questions is 20 test questions. Changes to questions before and after revision based on validation results and one to one are prototype 3 which are presented in table 8 below:

Table 8. Changes to Prototype 1 and Prototype 2 Questions (Before and after Revision)

Before	Validator Comment	After
Question #1: Simple form of $\left(\frac{7x^3y^{-1}z^5}{49y^4z^2}\right)^2$ is ... a) $\frac{1}{7^2}x^6y^{-10}z^6$ b) $7^2x^6y^{-10}z^6$ c) $7^{-2}x^6y^{-10}z^6$ d) $7^4x^6y^{-10}z^6$ e) $\frac{1}{7^4}x^{-6}y^{10}z^6$	Questions number 1 and 3 are not in accordance with the question indicators.	Consider the following function, which is an exponential function: I. $f(x) = 3^{x+2y}$ II. $f(x) = 1^6$ III. $f(x) = \left(\frac{1}{2}\right)^x$ IV. $f(x) = -2^x$ a. I, II and III b. I, II and IV c. I, III and IV d. II, III and IV e. All true
Question #3: $4^{3036} - 4^{3021} = \dots$ $4^{3033} - 4^{3015} = \dots$ a) 4 b) 16 c) 36 d) 64 e) 256		Given $f(x) = 3^{2x-1}$, find the value of $f(2)$ is ... a. 9 b. 12 c. 16 d. 25 e. 27
Question #15: Value x that satisfies the equation $\frac{\sqrt[3]{(0,008)^{8-3x}}}{(0,2)^{-4x+5}} = 1$ is ... a. $-\frac{1}{2}$ b. $-\frac{1}{3}$ c. 0 d. $\frac{1}{2}$ e. $\frac{1}{3}$	The questions are too difficult on numbers 15, 19, and 20.	Question is not used.
Question #19: The limits of x satisfies $(0,6)^{x+\frac{5}{x}} < 0,046656$ is ... a. $\{x x < 1\}$ b. $\{x 1 > x > 5\}$ c. $\{x 1 < x > 5\}$ d. $\{x 1 > x < 5\}$ e. $\{x x > 5\}$		Question is not used.
Question #20: From an equality $\left(\sqrt[3]{\frac{1}{243}}\right)^{3x} \leq \left(\frac{3}{2^{2x-3}}\right)^2 \sqrt[3]{\frac{1}{27}}$, if x is a solution, then the value of $\frac{7}{2}x + 5$ is ... a. -1 b. 1 c. 3 d. 6 e. 9		Question is not used.

3.4 Implementation

The implementation stage consists of two stages, namely the small group stage and the field test. The small group stage was carried out for 15 students in class X TPM at SMK PGRI 2 Palembang which was held on May 17 2022. The Exponential Function Exponential Question Exploration application was given to students via telegram and students were asked to install the application. After playing the Exponential Function Question Exploration Application the researcher asked students to fill out a student response questionnaire. The results of the student response questionnaire answers were used to analyze the practicality of the game-based test instrument that had been developed.

The field test stage was carried out in 1 class consisting of 30 class X TI 3 students at SMK PGRI 2 Palembang. This field test trial was carried out in 2 meetings. In the first meeting, the researchers carried out teaching and learning activities to recall the exponential function material that had been studied. In the second meeting, the researchers gave a game-based test instrument or Exponential Function Exploration Application which was used as a test tool for students. This field test stage was carried out to see the validity of the items, the reliability of the questions, the level of difficulty and the discriminating power of the questions empirically.

3.5 Evaluation

In the evaluation stage, the researcher analyzed the results of the development and implementation stages whether the game-based test instrument using RPG Maker MZ software on exponential function material was valid, practical and reliable. The explanation of the analysis results from the evaluation stage is as follows:

a) Validation Questionnaire Analysis Results

The validity of a game-based test instrument that has been developed comes from validation questionnaire data from three validators. The results of the questionnaire assessment are as follows.

Table 9. Validator 3 Assessment Result

Validator	Percentage	Description
Validator 1	80.00%	Valid
Validator 2	81.14%	Very valid
Validator 3	84.57%	Very valid
Average	81.90%	Very valid

From table 9 above, it is known that the average rating of the three validators is 81.90%. Based on table 1, the validity criteria for this percentage are in the Very Valid category. Thus it can be concluded that prototype 2 is feasible to be tested to the next stage.

b) Results of Student Response Questionnaire Analysis

The practicality of a game-based test instrument that has been developed comes from student response questionnaire data. The results of the student response questionnaire are as follows:

Table 10. Student Response Questionnaire Recapitulation Results

No.	Question	Total Score	Maximum Score	%
1	The appearance of the math test using this application is interesting.	57	75	76.00

2	This math test makes me more enthusiastic in learning math.	58	75	77.33
3	Using this application makes learning mathematics not boring.	66	75	88.00
4	The visual appearance of this test is very interesting.	57	75	76.00
5	The test using this application increases my motivation.	62	75	82.67
6	I am very interested in game-based tests using this application.	56	75	74.67
7	Learning mathematics with game-based tests using this application is less useful for me.	57	75	76.00
8	I prefer to work on test questions using this application.	58	75	77.33
9	The questions given are in accordance with what I learned at school.	62	75	82.67
10	The math test using this application is very practical.	60	75	80.00
11	The material presented is easy to understand.	63	75	84.00
12	This test tests the extent of my understanding of the material that has been studied at school.	63	75	84.00
13	The sentences used in the questions are clear and easy to understand.	64	75	85.33
14	The language used in this test is simple and easy to understand.	63	75	84.00
15	The mathematical symbols used are simple and easy to read.	63	75	84.00
16	With this application it is very easy at the time of the test.	59	75	78.67
17	It is more difficult to understand the questions given in this application.	60	75	80.00
18	This application is easy to access.	59	75	78.67

19	This application is easy to use.	62	75	82.67
20	The menus and buttons on this application are easy to use.	56	75	74.67
Average				80.33

From table 10 above, it can be seen that the average percentage of students' answers is 80.33%. Based on table 2 the practicality criteria, the percentage is in the practical category. So it can be concluded that the game-based test instrument is stated to be practical for use in the learning process.

c) Results of Analysis of the Validity of the Question Items

After the field test phase is completed and the results obtained from the test are obtained, the researcher then analyzes the answers of students. The item validity calculation is done by determining the product moment correlation from Karl Pearson using the SPSS 28 application. The calculation results show that 14 questions are valid, and 6 questions are invalid in question numbers 8, 9, 10, 12, 13, and 18 as shown in table 11 below.

Table 11. Validity Result

Question	r_{xy}	r_{table}	Description
1	0.415	0.361	Valid
2	0.415	0.361	Valid
3	0.415	0.361	Valid
4	0.578	0.361	Valid
5	0.402	0.361	Valid
6	0.415	0.361	Valid
7	0.415	0.361	Valid
8	0.151	0.361	Not valid
9	0.151	0.361	Not valid
10	0.234	0.361	Not valid
11	0.591	0.361	Valid
12	0.097	0.361	Not valid
13	0.054	0.361	Not valid
14	0.415	0.361	Valid
15	0.378	0.361	Valid
16	0.390	0.361	Valid
17	0.415	0.361	Valid
18	-0.036	0.361	Not valid
19	0.618	0.361	Valid
20	0.415	0.361	Valid

d) Results of Item Reliability Analysis

To see the level of reliability of game-based test instruments that have been developed, researchers used the Alpha Cronbach formula using the SPSS 28 application. The results of the reliability test questions are seen in table 12 below:

Table 12. Reliability Result

Cronbach's Alpha	N of items
0.608	20

Based on table 12 above it is known that the reliability coefficient obtained is 0.608 with high reliability criteria based on table 3.8. So it can be concluded that the 20 questions analyzed were reliable.

e) The results of the analysis of the difficulty level of the questions

Then to see the level of difficulty of the game-based test questions that have been developed, the researcher uses the SPSS 28 application and the calculation results are as follows:

Table 13. Difficulty Level Result

Question Number	Difficulty Level	Criteria
1	0.97	Easy
2	0.97	Easy
3	0.97	Easy
4	0.73	Easy
5	0.93	Easy
6	0.97	Easy
7	0.97	Easy
8	0.90	Easy
9	0.90	Easy
10	0.97	Easy
11	0.63	Moderate
12	0.90	Easy
13	0.97	Easy
14	0.97	Easy
15	0.67	Moderate
16	0.63	Moderate
17	0.97	Easy
18	0.97	Easy
19	0.67	Moderate
20	0.97	Easy

Based on table 13 above the results obtained from the 20 questions that have been tested there are 16 questions in the easy category, and 4 questions in the medium category.

f) Results of the Analysis of the Discriminating Power of the Problem

To see the level of discriminating power of game-based test items that have been developed, the researcher used the SPSS 28 application with the following results:

Based on table 14 below, the data obtained from the calculation of discriminating power is that there are 8 in the Bad category, 9 in the Fair category and 3 in the good category.

Table 14. Difficulty Level Result

Question Number	Distinct Power Level	Criteria
1	0.339	Adequate
2	0.339	Adequate
3	0.339	Adequate
4	0.407	Good
5	0.294	Adequate
6	0.339	Adequate
7	0.339	Adequate
8	0.005	Bad
9	0.005	Bad
10	0.150	Bad
11	0.405	Good
12	-0.049	Bad
13	-0.033	Bad
14	0.339	Adequate
15	0.159	Bad
16	0.167	Bad
17	0.339	Adequate
18	-0.122	Bad
19	0.444	Good
20	0.339	Adequate

Based on table 14 above, the data obtained from the calculation of discriminating power is that there are 8 in the Bad category, 9 in the Fair category and 3 in the Good category.

4. CONCLUSION

Based on the results of research and discussion on the development of game-based test instruments using RPG Maker MZ software on exponential function material, it is known that the validity of game-based test instruments obtained an average percentage of 3 validators of 81.90% with a very valid category. The practicality of game-based test instruments was obtained from students' assessment of game-based test instruments by filling out a student response questionnaire. The results of the assessment obtained a percentage of 80.33% in the practical category. Empirical validity, reliability, difficulty level and differentiability of game-based tests were obtained from the results of field tests. The results of the calculation of the validity of the items show that 14 questions are valid, 20 questions are reliable at 0.608 with a high reliability category, in the calculation of the level of difficulty there are 16 questions in the easy category, and 4 questions in the medium category, and the results of the calculation of discriminating power are 8 in the Bad category, 9 in the Enough category and 3 in the Good category.

5. RECOMMENDATION

Research suggests that the development of test instruments can be in the form of short questions or matching in order to reduce the possibility of guessing answers.

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ICARE's Pedagogic Approach in Development of Educational Profession Textbooks Based on Problem Based Learning

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Abstract: The purpose of the study was to develop textbooks and to determine the feasibility and effectiveness of PBL-Based Textbooks with ICARE's Pedagogic Approach used in professional education courses. Methods This research is research and development (R&D) using the Borg and Gall model. This research was conducted at the Department of PGSD, FIP Unimed in the Education Profession course. The research subjects are students and lecturers with expert validation, namely: material experts, learning design experts, and graphic design experts. And by conducting individual trials, small group trials, and field trials. The results showed that the PBL-Based Educational Profession Textbook ICARE's Pedagogic Approach was declared suitable for use in learning with very good criteria, and the effectiveness of using the PBL-based PBL Educational Profession Textbook ICARE's Pedagogic Approach could improve student learning outcomes in educational profession courses.

Keywords: paedagogic ICARE; textbooks; educational professions; problem based learning

1. INTRODUCTION

Educational profession courses are urgent subjects, especially for Unimed students. Through these courses, students will be equipped with the basic concepts of professional ethics, the teaching profession, the teaching profession, the code of ethics for the teaching profession, the organization of the association of the teaching profession, and knowledge of the development of the teaching profession. The purpose of this course is targeted so that students can increase their knowledge, understanding, and insight into the concept of professional ethics through various aspects related to educational careers.

Given the learning needs and development of students' thinking skills, the learning model used is appropriate. The ICARE model is designed to help students learn online effectively. ICARE's principle is to provide the necessary materials for each topic. The ICARE method allows you to easily apply what students have learned in real life. The ICARE method has five elements, namely introduction, connection, application, reflection, and extension. This method can grow students' character [1].

Improving learning through application and practice can provide a person with a meaningful learning experience [2]. Therefore, the student learning process should not only prioritize the acquisition of material but also need to apply it in real life.

This lecture can be used as a provision for prospective teachers and students to be able to study professionally. The delivery of the material is based on the grammar of the ICARE learning model and students' specific examples. It is

hoped that through this direct example, students can feel how this learning model attracts interest and increases their activities and learning outcomes. When students practice teaching in schools and later become teachers, they can also apply this model.

1.2 Theoretical framework

Nurdin [3] asserts that the profession is a field of work that is based on the education of certain skills. Define the profession as follows: "A profession delivers esoteric service based on esoteric knowledge systematically formulated and applied to the needs of a client" (a profession that provides services based on knowledge understood by certain people systematically formulated and applied to meet client requirements).

According to Nurdin [3], teachers are professional educators because they secretly voluntarily accept and carry out some of the educational responsibilities borne by their parents. Professionalization of teachers includes formal qualifications and teaching permits and requires the cultivation of real qualifications that are only available in practice [4]. According to Nurdin [3] teachers are people who want to be involved in teaching. Teaching is the main responsibility of teachers to educate students.

Professional teachers have knowledge and skills that some ordinary people do not have. With this knowledge and skills, teachers can carry out certain functions, namely making and implementing decisions, so that they can teach students most effectively and efficiently.

ICARE stands for Introduction, Connect, Apply, Reflect, and Extend. According to Wahyudin & Susilana [8], the stages in ICARE learning follow the abbreviation.

Problem-based learning is a learning model that involves students in solving problems through various stages of the scientific method so that students can learn knowledge related to these problems as well as have problem-solving skills [5]. According to research by Indrawati and Wawan Setiawan [6], problem-based learning is a learning model that uses the background of real-world problems to enable students to learn critical thinking and problem-solving skills, as well as obtain the topic of must Little. knowledge and concepts. . Problem-based teaching is used to stimulate higher-order thinking, including learning how to learn. The teacher's role in problem-based learning is to ask questions, ask questions, and promote inquiry and dialogue.

The problems of this research are: (1) how to develop ICARE pedagogic textbooks based on problem-based learning in education profession courses; (2) whether the PBL-Based Textbook of ICARE's Pedagogic Approach is appropriate for use in teaching profession courses; and (3) whether the PBL-Based Textbook of ICARE's Pedagogic Approach is effective in teaching profession courses

2. METHOD

This research is a research and development (R&D) and developed PBL-Based Educational Profession Textbook ICARE's Pedagogic Approach using the Borg and Gall model [7].

This research was conducted by the Department of PGSD, FIP Unimed, Academic Year 2021/2022, in the 6th semester of the Educational Profession course. By designing a PBL-Based Educational Profession Textbook, ICARE's Pedagogic Approach. The research subjects for the development of PBL-Based Educational Professional Textbooks with ICARE's Pedagogic Approach are expert groups, namely: learning materials experts, learning media experts, instructional design experts, and graphic design experts. Students and lecturers as subjects of development research in validation groups and individual trials, small group trials, and field trials.

Data collection in research and development is grouped into three, namely preliminary studies, development, and validation tests. In each stage of the research, certain data collection techniques were selected according to their respective objectives. In the preliminary study, a questionnaire/ questionnaire, observation, and documentation techniques were chosen, in addition to a literature review. In general, the three techniques are used simultaneously and complement each other.

The method used is a quasi-experimental method using a non-equivalent control group design. The design was used because of the limited population of the research sample and in this design the experimental group was not chosen randomly, then a pretest was given to determine whether there was a difference between the experimental group and the control group in the initial state.

Table 1. Experimental diagram (nonequivalent control group design).

Group	Pretest	Treatment	Posttest
Experimental group	O1	X	O2
Control group	O3	-	O4

The arrangement of the scale used in this questionnaire or questionnaire is based on a Likert scale (interval 1 to 5) and the average score for each question item in the questionnaire and evaluation sheet will be calculated. After that, the average score is converted into scores on a scale of 5.

Table 2. Assessment Criteria for PBL-Based Educational Profession Textbooks ICARE's Pedagogic Approach

Score	Criteria	Scoring	
		Formula	Calculation
5	Very Worthy	$X > Mi + 1,8 SBi$	$X > 4,2$
4	Worthy	$Mi + 0,6 SBi < X < Mi + 1,8 SBi$	$3,4 < X < 4,2$
3	Decent enough	$Mi - 0,6 SBi < X < Mi + 0,6 SBi$	$2,6 < X < 3,4$
2	less worthy	$Mi - 1,8 SBi < X < Mi - 0,6 SBi$	$1,8 < X < 2,6$
1	Very less worthy	$X < Mi - 1,8 SBi$	$X < 1,8$

Data collection techniques in this study use tests. The test is used for Pretest and Posttest.

Analysis technique with t-test. This analysis is measured based on the effectiveness of learning by using a question instrument and hypothesis testing using the t-test. The significant level used is 5%. After the t-test, the two classes were compared with the number of students who experienced an increase in effectiveness between the two classes.

3. RESULTS AND DISCUSSION

3.1 Research Result

The PBL-Based Educational Profession Textbook Product ICARE's Pedagogic Approach shows a high level of validity and feasibility so that the model product can be used in the learning process of educational profession courses.

3.2 Feasibility of PBL-Based Educational Profession Textbooks ICARE's Pedagogic Approach

The next stage on the results of the PBL-Based PBL-Based Educational Profession Textbook Trial to students in the educational profession was conducted with 32 respondents with varying abilities (randomly). The purpose of the first trial was to find out how far the students' response to the PBL-Based Educational Profession Textbook with ICARE's Pedagogic Approach was. The results of student respondents from the trial I / small groups are as follows:

Table 3. Trial Data for PBL-Based Educational Profession Textbooks ICARE's Pedagogic Approach

No	Indicator	Score Rating	Total Score	%
1	Face/Layout Aspect	4,72	5	85,2
2	Design Aspect	4,65	5	86,4
3	Content Feasibility Aspects	4,44	5	87,1
4	Aspects of Feasibility of Presentation	4,89	5	88,1

No	Indicator	Score Rating	Total Score	%
5	Language Aspects	4,53	5	85,6
	Average	4,47		89,3

Based on the results of the I/small group trial, the mean value was 4.47. With Good criteria. Overall, the results of the student assessments for the first trial obtained an average value of 4.47, which means that the PBL-Based Educational Profession Textbook ICARE's Pedagogic Approach is feasible to be used as a learning resource in teaching the educational profession.

3.2 Effectiveness Before Using PBL-Based Educational Professional Textbooks ICARE's Pedagogic Approach

To determine the effectiveness of student learning between the experimental class and the control class before being given treatment, the t-test was carried out with pretest data. To find out t_{table} using: $DK = n1+n2 - 2$. Criteria for acceptance of H_0 and H_a are if $t_{count} > t_{table}$ then H_0 is rejected and H_a is accepted, and if $t_{count} < t_{table}$ then H_0 is accepted, and H_a is rejected. The results of the pretest t-test calculation can be seen in table 4 below:

Table 4. Uji t-tes Data Pretest

Class	Mean	Variant	t_{count}	t_{table}	Decision
Experiment	76,44	65,72	0,45	2,01	$t_{count} < t_{table}$
Control	71,30	66,71			

Based on Table 4 above, it can be seen that the magnitude of t_{count} is 0.45. Then the t_{count} score was consulted with the t_{table} value at a significant level of 5% and DK 51. The t_{table} score at a significant level of 5% and DK 51 was 2.01. This shows that the t_{count} score is smaller than the t_{table} score ($t_{count} = 0.45 < t_{table} = 2.01$). Based on the calculation results, it can be concluded that there is no difference in early learning ability between the experimental class and the control class. If the students' posttest results show differences, then the difference in learning outcomes is caused by the treatment process using the PBL-Based Educational Profession Textbook ICARE's Pedagogic Approach that has not been applied.

3.3 Effectiveness After Implementing PBL-Based Educational Profession Textbooks ICARE's Pedagogic Approach

To determine the effectiveness of student learning between the experimental class and the control class after being treated using the PBL-Based Educational Profession Textbook with ICARE's Pedagogic Approach, a t-test of posttest data was used. To find out t_{table} using: $DK = n1+n2 - 2$. Criteria for acceptance of H_0 and H_a are if $t_{count} > t_{table}$ then H_0 is rejected and H_a is accepted, and if $t_{count} < t_{table}$ then H_0 is accepted, and H_a is rejected. The results of the pretest t-test calculation can be seen in table 5 below.

Table 5. Uji t-tes Data Posttest

Class	Mean	Variant	t_{count}	t_{table}	Decision
Experiment	86,52	82,49	4,03	2,01	$t_{count} > t_{table}$
Control	74,31	61,02			

Based on Table 5. above, it can be seen that the amount of t_{count} is 4.03. Then the t_{count} score was consulted with the t_{table} value at a significant level of 5% and DK 51. The t_{table} score at a significant level of 5% and DK 51 was 2.01. This shows that the t_{count} score is greater than the t_{table} score ($t_{count} = 4.03 > t_{table} = 2.01$). Thus H_0 is rejected and H_a is accepted. So that there is a significant difference in the value of the effectiveness of student learning after being treated using the PBL-Based Teaching Profession Textbook with ICARE's Pedagogic Approach.

3.3 Discussion

The learning outcomes of the experimental class students are more active and have high motivation in learning after the application of the Contextual Teaching and Learning learning model with the ICARE approach. CTL is a learning strategy that emphasizes the process of full student involvement to be able to find the material being studied and relate it to real-life situations to encourage students to be able to apply it in their lives with an ICT learning model approach that emphasizes active characteristics, creative, and fun (joyful learning) is the ICARE model [8].

Research conducted by Faulina and Fitria [9] on the effect of the CTL learning model with the ICARA approach on ICT lessons shows the same thing that the Contextual Teaching and Learning learning model with the ICARE approach (Introduction, Connection, Apply, Reflect, Extend) turns out to be more influential on the results. learning Information and Communication Technology (ICT) significantly compared to using conventional learning models.

The application of the ICARE learning model is by several other researchers who are used as references, who first conducted research on the development of the ICARE learning model in class expansion according to the culture and character of students, and found that the learning outcomes (knowledge) of students were higher by using the model. ICARE, Kuntum a Nisa, et al [10] who researched that the ICARE approach can improve the General Life Skills of autistic children, and Siti Syahidatufalah [11] who researched that there was an increase in creative thinking using ICARE-based problem-solving learning models and Scientific Approaches, and Desi Wulandari, et al [12] who examined the development of ICARE-K learning with character. Based on the results of the study, it was concluded that the ICARE learning model affected student learning outcomes. This is because the ICARE learning model can create interesting learning for students so that they are active in the learning process. Learning becomes more meaningful for students so student learning outcomes increase.

The results of research conducted by Triani, Wahyuni, Purwanti, et al. [12], the practical-assisted I-CARE learning show the same thing that the implications of the application of this practicum-assisted I-CARE model are that (1) the practicum-assisted I-CARE model is a learning model that prioritizes contextual aspects based on students' daily experiences and strengthening problem-solving skills in a

holistic, systemic, integrated, and meaningful way, starting from the introduction of concepts and problems to implementation; (2) the application of the I-CARE model assisted by practicum must be carried out flexibly, adjusting to class/environment conditions and student characteristics, although the syntax includes the stages of introduction, connect, apply, reflect, and extend); (3) the I-CARE model is flexible, universal, and open to continuous development according to the characteristics of the material and subjects.

The results of Wahyudin's research [8], show that the ICT learning model through the ICARE model has a positive effect and can be developed into more meaningful and fun learning. Referring to the statistical test of 0.05 (95% significance level) and comparing the results of the pre-test and post-test, this study proves that the ICARE model affects mastery of the material. Validation tests at the same level of significance show that in rural schools, border schools between cities, and schools in urban areas, the ICT learning model through ICARE is more effective than other models that have been practiced by teachers.

Research conducted by Suendarti & Liberna [13], shows that the ICARE model can also help students' metacognition so that students' construction in learning will be better. With the use of manipulative learning media, there is a reciprocal relationship between students and teachers or vice versa. This is supported by the research of Suweken [14] which states that the application of mathlete (GeoGebra) during the learning process makes the level of student involvement in learning improve and the learning achievement of students who are taught by GeoGebra is higher than the achievement of students who are not taught by GeoGebra. Similar results were also found in several studies [15] [16] [17], where from the results of his research it was found that the GeoGebra media-assisted learning device was able to improve student learning activities and students' mathematical communication skills. Each learning activity is based on the ICARE model in the student book.

4. CONCLUSION

Eligibility of PBL-Based Educational Profession Textbooks ICARE's Pedagogic Approach was declared suitable for use in learning, based on the assessment of material experts, learning design experts, and graphic design experts getting good marks. The results of trial I and trial II got a very good average value. So, based on the results of the data obtained from the assessment of material experts, media experts, lecturers, trial I, and trial II, it was stated that the PBL-Based Educational Profession Textbook of ICARE's Pedagogic Approach was with Good criteria.

The effectiveness of learning has increased in the experimental class using the PBL-Based Educational Profession Textbook with the ICARE Pedagogic Approach than in the control class where the learning process does not use the ICARE Pedagogic Approach. The use of PBL-Based Educational Profession Textbooks ICARE's Pedagogic Approach is highly expected by students in learning, so as to improve learning outcomes for the educational profession.

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Development of Student Worksheets Based on Problem-Based Learning Integrated HOTS Social Science Subjects

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Abstract: This research and development aim to (1) Assess the feasibility of PBL-based LKPD integrated HOTS social studies material; and (2) Assess the effectiveness of the PBL-based LKPD integrated HOTS for IPS material. This research method is research and development (R&D) in class VIII SMPN 1 Sei Suka, Batubara. The test results prove that there is a significant difference between student learning outcomes who are taught using the HOTS-integrated PBL-based LKPD and the results of the regular LKPD. The development is carried out through expert validation tests: material, learning design, graphic design experts, and trials: individuals, small groups, and the field. The data on the quality of this development product was collected using a questionnaire and analyzed using qualitative descriptive analysis techniques. The results showed; (1) the material expert test is on very good criteria and is suitable for use, (2) the learning design expert test is on the very good criteria and is suitable for use, (3) the learning media expert test is on the very good criteria and is suitable for use, (4) individual trials are on very good criteria, (5) small group trials are on very good criteria, and (6) field trials are on very good criteria. The effectiveness of the developed product shows that students' social studies learning outcomes are more effective using the HOTS-integrated PBL-based LKPD than the regular LKPD.

Keywords: student worksheets; problem-based learning; HOTS; social science

1. INTRODUCTION

The development of science, technology, and changes in society at the local, national, and international levels are the main foundations in the development of the 2013 Curriculum. (Information and Communication Technology) students to face global challenges in the 21st century. As part of the world community, students must understand the environment and society locally, nationally, and globally, be aware of cultural diversity (multicultural), develop social skills, and master technological developments [1].

Social Studies subject is one of the compulsory subjects in SMP/MTs which integrates the concepts of geography, sociology, economics, and history. Social Studies subjects use geography as a starting point (platform) for studies by considering all places, objects, resources, and events tied to location. The aim is to emphasize the importance of space as a place of life and resources for humans, recognizing the potential and limitations of space, that's why space is always interconnected (inter-space connectivity) to complement each other. As a result of the interaction between nature and humans, as well as connectivity between spaces, the conditions of space are constantly changing according to time and the development of technology used by humans.

Social studies learning is organized with an interdisciplinary, multidisciplinary, or transdisciplinary approach from Social Sciences, Humanities, and Psychology according to the development of students [2]. In the context of social studies learning, space is defined as the space of life in the Unitary

State of the Republic of Indonesia (NKRI). Social studies learning is expected to develop a sense of love for the homeland, and strengthen the unity and integrity of the Unitary Republic of Indonesia. As for the context of the formation of Indonesian people, social studies learning in SMP/MTs is expected to provide an understanding of the environment and society in the national and international scope so that they can develop knowledge, attitudes, think logically, systematically, critically, analytically, and socially. All of that, in the end, can increase understanding of the potential of Indonesia's territory, also develop nationalism, strengthen national attitudes, and be able to work together in a pluralistic society as citizens, citizens, and citizens of the world.

The 2013 curriculum expects teachers to be able to make Higher Order Thinking Skill (HOTS) questions and can create their own HOTS question bank for students to study. The purpose of the HOTS questions is to test students' abilities from the level of analysis to creating. The ability from the level of analysis to creation is very important in today's era of globalization, where world barriers no longer exist, in the context of work various people from various countries are very likely to become our competitors. Therefore, as the next generation, students must have competent cognitive abilities in terms of analysis, evaluation, and the creation of new things.

Higher order thinking skills are one of the thinking processes that do not only remember and convey information received, but also require being able to connect, manipulate, and transform knowledge and experience that has been received to think critically and creatively to make decisions and solve

problems in situations. new [3]. Students can be said to have higher-order thinking skills if these students obtain new information from the results of manipulating existing information in their way [4]. Higher order thinking skills are closely related to Bloom's Taxonomy.

Weak LKPD on students causes students' understanding when working on questions, especially HOTS questions to find problems. From the results of preliminary research conducted in class VIII using interview instruments, it is known that students have low higher-order thinking skills. Based on the author's observations, the LKPD used for class VIII students of SMPN 1 Sei Suka, Batubara is not completely PBL-based as well as the questions contained in the LKPD have not been made students have higher-order thinking skills. In fact, in the 2013 curriculum, teachers are expected to be able to arrange HOTS questions so that students do not only answer at levels C-1 (knowing), C2 (understanding), and C-3 (applying), but also level C-4 (analyzing), C-5 (evaluate), C-6 (create) [5]. 84% of the teachers of SMP N 1 Sei Suka, Batubara have not been able to make questions that make students think at a higher level. This is in stark contrast to the demands of the 2013 curriculum.

Thus, PBL-based worksheets like this indirectly facilitate the achievement of learning objectives. Because through things that are often seen, experienced, and found in the lives of students, if they are properly linked to the learning content, they can create meaningful learning [6]. This was before the researchers developed learning tools in the form of PBL-based worksheets. Researchers consider several things including the suitability of PBL-based LKPD with the characteristics of the material to be taught. The PBL-based IPS LKPD which will be developed by researchers is in the form of a product and synchronized with the characteristics of the material on the topic of discussion according to the Basic Competencies.

This subject is one of the interesting materials in the Social Studies subject for class VIII semester 2. This is because of each component of the subject matter such as; The Arrival of Western Nations to Indonesia; Conditions of Indonesian Society during the Colonial Period; and the Growth and Development of the National Spirit. This material change activity is often seen and also carried out by students. For this reason, researchers plan to implement the PBL concept in social studies learning which is realized in PBL-based LKPD and is associated with the daily activities of students (contextual) at the junior high school level by the subject matter of "Changes in Indonesian Society in the Colonial Period and the Growth of Spirit". Nationality". In addition, class VIII junior high school students are just starting to think logically in solving problems, so they still need intensive guidance from the teacher in learning [7]. This is the background of the researchers who set students in class VIII as objects in this study.

1.1 Learning Outcomes of Social Sciences (IPS)

Learning outcomes are a measure or level of success that can be achieved by a student based on the experience gained after an evaluation in the form of a test and is usually manifested by certain values or numbers and causes cognitive, affective, and psychomotor changes [8].

The cognitive, affective, and psychomotor areas as learning outcomes are formulated by Bloom [9] where each aspect has

an educational goal. The cognitive area includes educational goals related to the remembrance or recognition of knowledge and the development of intellectual skills and abilities. The effective area includes educational goals that describe changes in interests, attitudes, values, and the development of appreciation. The psychomotor area includes learning outcomes related to manipulation and limb movement skills. In this study, learning outcomes were measured using Bloom's taxonomy which was revised by Anderson and Krathwohl.

The scope of development of HOTS-based PBL-based LKPD in social studies material includes: (1) understanding spatial changes and interactions between spaces in Indonesia and ASEAN countries caused by natural and human factors (technology, economy, land use, politics) and their effects on sustainability economic, social, cultural, political life; (2) spatial changes and interactions between spaces in Indonesia and ASEAN countries caused by natural and human factors (technology, economy, land use, politics) and their influence on the sustainability of economic, social, cultural, political life; (3) the influence of social interaction in different spaces on socio-cultural life and the development of national life; (4) the influence of social interaction in different spaces on social and cultural life as well as the development of national life; (5) analyze the advantages and limitations of space in supply and demand, technology and its influence on the interaction between spaces for economic, social, cultural activities in Indonesia and ASEAN countries; (6) presents the results of an analysis of the advantages and limitations of space in demand and supply, technology and its influence on the interaction between spaces for economic, social, cultural activities in Indonesia and ASEAN countries; (7) analyze the chronology, changes and continuity of space (geographic, political, economic, educational, social, cultural) from the colonial period to the growth of the national spirit; and (8) presenting a chronology of changes and spatial continuity (geographical, political, economic, educational, social, cultural) from the colonial period to the growth of the national spirit.

Thus, what is meant by learning outcomes in this study is the level of success that can be achieved by a student based on the experience gained after an evaluation in the form of a test that causes changes that include remember (remember), understand (understand), apply (apply), analyze (analyze), evaluate (evaluate), create (create). In addition, it is also seen with practical assessments.

1.2 Student Worksheets Based on PBL

LKPD is a learning tool developed by teachers as a facility for improving learning activities. LKPD is prepared by design and can be developed according to the situation and conditions of the learning activities to be carried out [10]. The teacher himself understands and understands the conditions of learning, both in the classroom and in the learning environment of his students.

According to the Ministry of National Education, LKPD (student worksheets) are sheets containing tasks that must be done by students, usually in the form of instructions, and steps to complete a task by referring to the Basic Competencies (KD) that will be achieved. This is in line with the opinion of another expert Majid [11] who stated that; "Student worksheets are sheets containing assignments that must be done by students. LKPD is usually in the form of instructions, and steps to complete a task. The tasks ordered in the LKPD must be clear about the basic competencies to be achieved". Meanwhile, according to Katrina, and Laila [12] Student Worksheets are

sheets containing work steps that must be done by students. LKPD is in the form of sheets in which there are activities to be carried out by students equipped with work steps so that students can carry out activities according to the instructions. In the use of LKPD, the teacher acts as a facilitator for students so that it can stimulate students to be more active. The utilization of LKPD must look at the conditions and needs of the learning activities to be carried out.

LKPD is a learning tool that plays an important role in learning. According to Relia, and Lika [13], LKPD has printed teaching materials in the form of sheets of paper containing material, summaries, and instructions for implementing learning that must be done by students, which refers to the achievement of a basic concept that must be achieved. So, according to the opinion above, it can be seen that LKPD is a collection of sheets of paper containing material, tasks that must be carried out in learning activities, and steps that must be taken in learning. The tasks given in the LKPD must be clear and by the material so that the basic competencies and learning objectives to be achieved can be achieved properly as expected.

LKPD is one of the learning resources known in the 2013 curriculum which is used to assist teachers in training students' skills in finding concepts through work steps and problems provided along with assessment techniques. Teachers are required to be able to carry out learning according to the applicable curriculum. Therefore, it is necessary to have learning tools that actively develop students. LKPD is a means to assist and facilitate teaching and learning activities so that effective interaction is formed between students and educators, which can increase student learning activities and achievements.

LKPD can be developed referring to the PBL strategy. The PBL strategy requires the teacher to help students find their data, information, and facts from various sources so that this activity becomes an experience for students to solve other problems [14]. And so that students understand and can apply knowledge, students must work to solve problems, find things on their own, and try hard with their own id [15]. So that

students' creative thinking skills can be honed through problem problem-solving of phenomena or facts that occur.

The main problems in this study are: (1) how is the feasibility of the PBL-based IPS LKPD integrated HOTS in Social Studies subjects for Class VIII SMP; (2) how is the effectiveness of the HOTS-based PBL-based IPS LKPD in Social Studies subjects for Class VIII SMP.

2. METHOD

This research includes Research and Development. In this study, a valid, practical, and effective station rotation blended learning model was developed, and learning tools and Instrumente nts needed for the development process of the HOTS-based PBL-based IPS LKPD. The development process uses the Borg & Gall model.

The place for this research is in class VIII of SMPN 1 Sei Suka, North Sumatra. The subjects of this study were teachers and students in the second semester of the 2021/2022 academic year. At the stage of developing the HOTS-based PBL IPS LKPD, the targeting, in this case, is lecturers, learning experts, the field of study experts, and students who assess learning teaching materials that have been developed based on the following criteria: (1) evaluation of learning experts (expert judgment) is determined based on the expertise it has, (2) the evaluator who carries out the evaluation is determined based on the ability of the experts with the classification of experts in the field of study.

Data collection in research and development is divided into three parts, namely preliminary research, development, and verification testing. At each stage of the study, certain data collection techniques were selected according to their respective objectives. In the preliminary study, in addition to the literature study, questionnaires, observations, and document recording techniques were also selected. Generally, these three technologies can be used simultaneously and complement each other.

Table 1. Grid of the HOTS-based Integrated PBL LKPD IPS Assessment Instruments

Aspect	Component	Indicator
Contents	Learning approaches	Emphasis on the learning process
		Emphasizes the relationship between science and technology and life
		The suitability of learning activities with the applied approach
		Inviting students to be active in learning
	Concept truth	Conformity of the concept with the concept put forward by the experts
		The truth of the material arrangement
	Concept depth	The depth of the material according to the ability of students
	Concept suitability	Conformity of the concept with the classification material and material changes in the curriculum
	The suitability of the experimental activities with the material in the curriculum	
	The information presented follows the times	
Presentation	Learning Activities	Student involvement in learning activities Student-centred
		Suitability with learning characteristics
		Ability to stimulate students' depth of thinking through illustrations, case analysis, and practice questions
	Experiment activity	Providing hands-on experience
		The student activities are carried out to encourage students to conclude the concepts, laws, or facts being studied
		Practical activities/trials are easy to implement
	Execution	The subject matter is by the time allocation at school
		The relationship between learning activities
Evaluation	The assessment instructions used are easy to understand, precise and clear	

		Measuring cognitive, affective, and psychomotor abilities
		Measuring the achievement of learning success indicators
Appearance language	Contents	The suitability/accuracy of the illustration with the material
		Presentation of text, tables, images, and attachments accompanied by references/reference sources
		The balance between text and illustrations
		Glossary clarity
	Visualization	The accuracy of the color selection in the image
		Print images and clear writing
		LKPD physical appearance can encourage students' reading interest
language	Sentence clarity	Sentences are easy to understand and do not cause double meaning
		The language uses standard language
		The language used is communicative

Rajagukguk [16]

The method used is a quasi-experimental method using a non-equivalent control group design. This design was used because of the limited population of the research sample and in this design the experimental group was not chosen randomly, then a pretest was given to determine whether there was a difference between the experimental group and the control group in the initial state.

Table 2. Experimental diagram (non-equivalent control group design).

Group	Pretest	Treatment	Posttest
Experimental group	O1	X	O2
Control group	O3	-	O4

The arrangement of the scale used in this questionnaire or questionnaire is based on a Likert scale (interval 1 to 5) and the average score for each question item in the questionnaire and evaluation sheet will be calculated. After that, the average score is converted into scores on a scale of 5.

Table 3. Assessment criteria for HOTS-based IPS LKPD IPS

Score	Criteria	Scoring	
		Formula	Calculation
5	Very Worthy	$X > Mi + 1,8 SBi$	$X > 4,24$
4	Worthy	$Mi + 0,6 SBi < X < Mi + 1,8 SBi$	$3,4 < X < 4,2$
3	Decent enough	$Mi - 0,6 SBi < X < Mi + 0,6 SBi$	$2,6 < X < 3,4$
2	less worthy	$Mi - 1,8 SBi < X < Mi - 0,6 SBi$	$1,8 < X < 2,6$
1	Very less worthy	$X < Mi - 1,8 SBi$	$X < 1,8$

Data collection techniques in this study use tests. The test is used for Pretest and Posttest. Analysis technique with t-test. This analysis is measured based on the effectiveness of learning using a question instrument and hypothesis testing using the t-test. The significant level used is 5%. After the t-test, the two classes were compared with the number of students who experienced an increase in effectiveness between the two classes.

3. RESULTS AND DISCUSSION

The product development of the HOTS-based PBL IPS LKPD shows a high level of validity and feasibility so that the model

product can be used in the learning process of social studies subjects.

3.1 Feasibility of integrated PBL-based IPS LKPD HOTS

The next stage of the results of the PBL-based HOTS-based IPS LKPD Trial to students in social studies learning was carried out with 32 students with varying abilities (randomly) as respondents. The selection of individual trial subjects worked with subject teachers to guide the use of the HOTS-based integrated PBL IPS LKPD. The purpose of the first trial was to find out the extent to which students' responses to the HOTS-based PBL-based IPS LKPD were integrated. The results of student respondents from the trial I / small groups are as follows:

Table 4. HOTS-based integrated PBL-based LKPD IPS trial data

No	Indicator	Score Rating	Total Score	%
1	Face/Layout Aspect	4,02	5	80,4
2	Design Aspect	3,75	5	84,5
3	Content Feasibility Aspects	3,64	5	83,1
4	Aspects of Feasibility of Presentation	3,69	5	88,9
5	Language Aspects	3,73	5	87,3
	Average	3,71	5	82,5

Based on the results of the trial I/small group, the average value was 3.71. With Good criteria. Overall, the results of the student assessments for the first trial obtained an average value of 3.71, which means that the HOTS-based integrated PBL IPS LKPD is feasible to be used as a learning resource in social studies learning.

3.2 Effectiveness of Student Learning Before Implementing HOTS-based IPS LKPD IPS

To determine the effectiveness of student learning between the experimental class and the control class before being given treatment, the t-test was carried out with pretest data. To find out t table use: $dk = n1+n2 - 2$. Criteria for acceptance of H_0 and H_a are if $t_{count} > t_{table}$ then H_0 is rejected and H_a is accepted, and if $t_{count} < t_{table}$ then H_0 is accepted and H_a is rejected. The results of the pretest t-test calculation can be seen in table 5 below:

Table 5. Uji t-tes Data Pretest

Class	Mean	Variant	t _{count}	t _{table}	Decision
Experiment	56,44	67,74	0,44	2,01	t _{count} < t _{table}
Control	66,30	76,72			

Based on Table 5 above, it can be seen that the magnitude of the tcount is 0.44. Then the tcount score was consulted with the ttable value at a significant level of 5% and dk 51. The ttable score at a significant level of 5% and dk 51 was 2.01. This shows that the ttable score is smaller than the ttable score (t_{count} = 0.44 < t_{table} = 2.01). Based on the calculation results, it can be concluded that there is no difference in early learning ability between the experimental class and the control class. If the students' post-test results show differences, then the difference in learning outcomes is due to the treatment process using the HOTS-based integrated PBL LKPD IPS that has not been applied.

3.3 Effectiveness of learning after implementing the HOTS-based integrated PBL IPS LKPD

To determine the effectiveness of student learning between the experimental class and the control class after being treated using the HOTS-based integrated PBL IPS LKPD, it was carried out using a t-test of posttest data. To find out t table using: dk = n1+n2 - 2. Criteria for acceptance of Ho and Ha are if t_{count} > t_{table} then Ho is rejected and Ha is accepted, and if t_{count} < t_{table} then Ho is accepted and Ha is rejected. The results of the pretest t-test calculation can be seen in table 6. below:

Table 6. t-test Data Posttest

Class	Mean	Variant	t _{count}	t _{table}	Decision
Experiment	76,55	92,49	4,02	2,01	t _{count} > t _{table}
Control	69,30	70,02			

Based on Table 6. above, it can be seen that the magnitude of the tcount is 4.02. Then the tcount score was consulted with the ttable value at a significant level of 5% and dk 51. The ttable score at a significant level of 5% and dk 51 was 2.01. This shows that the tcount score is greater than the ttable score (t_{count} = 4.02 > t_{table} = 2.01). Thus Ho is rejected and Ha is accepted. So that there is a significant difference in the value of student learning effectiveness after being treated using the HOTS-based integrated PBL IPS LKPD.

The relationship between the HOTS-based integrated PBL IPS LKPD in this study helps students in higher-order and creative thinking, so what Arends, Richard I said. [17] states that there is a relationship between PBL and creative thinking because PBL is a learning approach where Students are faced with authentic (real) problems so that students are expected to be able to construct their knowledge, develop higher-order thinking skills, and make students independent and increase their self-confidence. Yusuf, M. [18] also stated that PBL can develop students' thinking skills, practice problem-solving skills, and improve subject matter mastery because PBL is applied to stimulate higher order thinking in problem-oriented situations, including learning how to learn.

HOTS-based PBL-based IPS LKPD according to the research results. The PBL strategy requires teachers to help students find their data, information, and facts from various sources so that this activity becomes an experience for students to solve other problems. And so that students understand and can apply knowledge, students must work to solve problems, find things on their own, and try hard with their ideas [18]. So that students' creative thinking skills can be honed through problem-solving analysis of phenomena or facts that occur.

Other research shows that the HOTS-integrated PBL-based Social Worksheet LKPD requires students to develop knowledge significantly, so according to Nuriyah, and Siti [18], the PBL learning model supports chemical equilibrium material because it has learning characteristics that begin with a problem, usually, the problem has a context with In the real world, students in groups actively formulate problems and identify gaps in students' knowledge, study and find material related to the problem themselves, and report solutions to problems.

Sofyan, Herminarto [19] in his research states that student learning outcomes in the realm of knowledge, attitudes, and skills of students with the PBL model equipped with LKPD are categorized as good with the percentage of students who achieve the core competencies of the 2013 curriculum respectively are 78%, 81.24 %, and 78.13%, indicating that there is a positive influence on the application of the PBL learning model to the student's understanding of concepts in SMAN 1 Paraung on Chemical Balance material. Based on the above background, PBL-based worksheets were developed to train students in creative thinking on chemical equilibrium material. The objectives to be achieved in this research are: (1) Knowing the feasibility of PBL-based LKPD to train students' creative thinking. (2) knowing students' responses to the developed LKPD and (3) knowing the role of PBL-based LKPD in training students' creative thinking.

4. CONCLUSION

The feasibility of the HOTS-based integrated PBL IPS LKPD is declared suitable for use in learning social studies subjects, based on assessments from material experts, learning design experts, and graphic design experts getting good grades. The results of trial I and trial II got a very good average value. So based on the results of the data obtained from the assessment of material experts, media experts, lecturers, trial I, and trial II it was stated that the PBL-based LKPD IPS was integrated with HOTS with Good criteria.

The effectiveness of student learning has increased in the experimental class that uses the HOTS-based PBL IPS LKPD compared to learning in the control class where the learning process does not use the usual LKPD. The use of the HOTS-integrated PBL-based IPS LKPD is highly expected by students in the learning process, so that it can improve social studies learning outcomes for class VIII SMPN 1 Sei Suka, North Sumatra.

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Development of a Digital Portal as a Learning Resource Computer Numerical Control (CNC) Machining Engineering Course

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Abstract: This journal reviews the mindset of educators in Indonesia. Times have changed, technological developments have become more sophisticated, information flows so fast, but the mindset of educators has not changed much. Educators in the revolutionary era 3.0 are educators who act as facilitators. This means that educators cannot dominate the learning process. Students actively learn and educators facilitate the learning process. Meanwhile, educators in the revolutionary era 4.0 are students as teachers. In this era students can act as educators. Students become content creators, become producers, and become conductors. So what is the position of educators in the 4.0 revolution, educators must be able to activate, curate and develop learning resources with various digital channels. According to AECT (Association for Education and Communication Technology) learning resources are one of the keys to success in achieving learning goals. Based on these problems, this research is still very much needed.

The type of research used is research and development (Research and Development). This study only looks at the feasibility and practicality of digital portals as learning resources for computer numerical control (CNC) machining techniques courses. The development of this learning product is arranged programmatically with a systematic sequence covering six stages, namely: literature study, development planning or design, product development, expert validation, trials, revisions, final product. The test subjects consisted of three material experts for the CNC machining engineering course, three learning design experts, three learning media experts, and a practicality test consisting of thirty students from the mechanical engineering education study program. Data about the quality of this development product is collected by questionnaire. The collected data were analyzed using qualitative descriptive analysis techniques.

The research results show; (1) the expert test for the subject matter for the CNC machining engineering course is in the Valid qualification (91.67%); (2) the learning design expert test is in the Valid qualification (94.20%); (3) the media expert test is in the Valid qualification (94.52%); (4) test the practicality of digital portals as learning resources computer numerical control (CNC) machining techniques courses by student responses showed a level of practicality with a percentage of 95.8% in the very practical category.

The results of this research study concluded that the digital portal as a learning resource for CNC machining engineering courses is feasible and practical to use in achieving student learning goals in the CNC machining engineering course in the Mechanical Engineering Education Department, Faculty of Engineering, Medan State University.

Keywords: Learning Resources; CNC Machining Techniques; Digital

1. INTRODUCTION

The development of education to date has progressed very rapidly and has become a major contribution to people's lives. Factors that influence the journey of education include curriculum, facilities and infrastructure, technology used and available learning resources. All the factors that support this will certainly bring about better changes than before [1]. One factor, for example the learning resources available on campus and off campus, is a necessity that must be met to provide students with comfort in learning. The existence of a complete learning resource will influence the progress of ways of thinking in solving problems in each subject matter. Therefore learning resources are one of the solutions and a must in answering educational problems [2].

According to Syawal Gultom, the main problem for educators in Indonesia is mindset. The times have changed, technological developments have become more sophisticated, the flow of information is so fast, but the mindset of educators has not changed much. Educators in the Revolution 3.0 era are educators who act as facilitators. This means that educators

cannot dominate the learning process. Students actively learn and educators facilitate the learning process. While educators at 4.0 are students as teachers. In this era students can act as educators. Students become content creators, producers, and conductors. So what is the position of educators in the 4.0 revolution, educators must be able to activate, curate and develop learning resources. Learning resources are one of the keys to success in achieving learning objectives. Based on these problems, this research is still very much needed [3]. Available learning resources can be harmed in various types such as people, tools, materials, teaching activities, environment. All of these learning resources can be maximized if they can be combined and fulfilled as a whole. However, several learning resources are currently not being utilized properly because they require the development of learning resources that go through a long process, such as digital website-based learning resource portals [4][5][6][7].

Based on observations made at the Department of Mechanical Engineering Education, Faculty of Engineering, Medan State University, researchers found several obstacles experienced

by lecturers in the learning process of CNC machining engineering courses, one of which was the problem of fulfilling learning resources. First, until now learning resources have not been developed that can be used for independent and group learning needs digitally by supporting lecturers based on not yet mastering the development of website-based digital learning resources, especially on CNC material. Second, there are gaps in the teaching process, including the professional skills of lecturers who are unsatisfactory, positions, roles, and functional relationships with other fields of study are neglected, factual information relies more on textbooks that are out of date. Third, the lecturers have made no effort to develop materials, the minimal use of digital technology/channels that can be used as a means of curating materials needed by students, and the lack of utilization of other sources, and the lack of attention to student needs. Fourth, students do not have experience because they have never used a website-based learning resource portal but already have devices to access website-based digital learning resource portals.

2. RESEARCH METHODS

The research method used is research and development (Research and Development). The development of this learning product is arranged programmatically with a systematic sequence covering six stages, namely: literature study, development planning or design, product development, expert validation, trials, revisions, final product [8][9][10]. Subjects The trial consisted of three material experts for the CNC machining engineering course, three learning design experts, three learning media experts, and a practicality test consisting of thirty students from the mechanical engineering education study program. The population in this study were odd semester students of the Department of Mechanical Engineering, Faculty of Engineering, Medan State University, Academic Year 2022/2023, while the sample in this study was 30 students. Data on the quality of this development product were collected by means of a questionnaire (validation and practicality sheet).

1) Validity Analysis Techniques for Digital Learning Resources Portals

The collected data were analyzed using qualitative descriptive analysis techniques. Data validation results of digital learning resources portals in the form of content validation, presentation validation, and format validation were analyzed using the following steps: Syaifuddin Azwar (112-112: 2013) [11], one of the statistics showing the validity of the item content is as proposed by Aiken (1985). Aiken has formulated the Aiken V formula to calculate the content-validity coefficient which is based on the results of an assessment by a panel of experts of n people on an item in terms of the extent to which the item represents the construct being measured. In this case representing the construct being measured means the item in question is relevant to the behavioral indicator, because the behavioral indicator is the operational translation of the attribute being measured.

The assessment is carried out by giving a number between 1 (ie not very representative or very irrelevant) to 5 (ie very representative or very relevant). Aiken's V statistics are formulated as follows:

Table 1. Categories of Learning Resources digital portal validit

Number	Achievement Level	Kategori
1	$\geq 0,6$	Valid
2	$< 0,6$	Invalid

Modified by: Saifuddin Azwar (2013:112-113)

2) Practicality Analysis Techniques for Learning Resources digital portals

Practicality test data for digital portals of learning resources obtained from practicality data by students are analyzed using the following steps:

a. Give an answer score with the following criteria:

4 = very practical, 3 = practical, 2 = quite practical, 1 = not practical, 0 = impractical.

b. Add up the scores of each validator for all indicators.

c. Giving practicality percentage value.

d. To determine the level of practicality the criteria in table 2 below:

Table 2. Value Range and Practicality category

Number	Achievement Rate (%)	Category
1	90 – 100	Very Practical
2	80 – 89	Practical
3	65 – 79	Pretty Practical
4	55 – 64	Less Practical
5	0 - 54	Impractical

Source ngalim Purwanto (2009: 82)

3. HASIL DAN DISKUSI

A. Product Specifications

The specifications or learning features of the products produced are as follows:

1. Learning Materials / Content

For learning resources to be used optimally, the teaching materials included in the learning portal are material that contains text in the form of e-books, audio-visual in the form of CNC videos, and pictures related to presentations.

2. Online Assessment System

The assessment system used in this learning resource is online (google form). The advantage is that the lecturer can determine the time that can be arranged and adjusted to the meeting used for assessment. In this study, there were 2 assessments carried out, namely the pretest and posttest which contained the same multiple choice questions but differed in the order of number and optional location. This assessment also makes it easier for students to answer without having to use stationery and is more transparent in the description of right and wrong answers.

3. Chat facility

Chatting facilities are used by lecturers and students in interacting in cyberspace, making it easier to exchange information about the lecture material.

B. Product Validity and Practicality

Based on product validation through a series of trials and revisions that have been carried out, the digital portal as a learning resource for computer numerical control (CNC) machining techniques has a valid status. The trial was carried out in 3 stages, namely: (1) Material expert test, (2) Learning design expert test, (3) Learning media expert test.

The research results show:

1. Material Expert

The assessment was carried out to obtain information that will be used to improve the quality of digital portal learning resources for CNC machining engineering courses for students majoring in odd-semester mechanical engineering education. The results of the validation in the form of an assessment score of the components of the digital portal of learning resources on the quality of learning materials can be seen in Table 3.

According to material experts on the quality of digital portals of learning resources, from the aspect of the quality of learning materials, the majority are in the Valid qualification (91.67%).

Table 3. Rating Scores of Digital Learning Resources Portals by Material Experts.

Number	Aspect	Average	Criteria
1	Material Quality	0.95	Valid
2	Strategies for Learning Basic CNC Machining Techniques	0.92	Valid
	Mean (average)	0.92	Valid

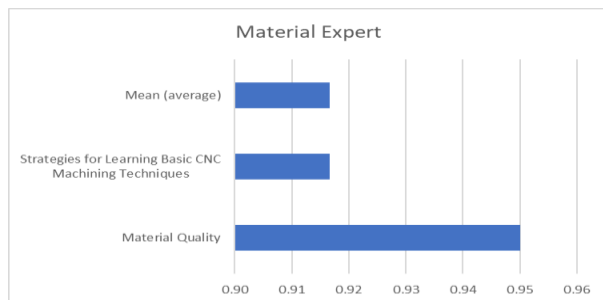


Figure 1. Diagram of the average value of the material expert test

2. Learning Design Expert

The assessment was carried out to obtain information that will be used to improve the quality of digital portal learning resources for CNC machining engineering courses for students majoring in odd-semester mechanical engineering education. The results of the validation in the form of an assessment score of the components of the digital learning resource portal on the quality of the learning design can be seen in Table 4. According to learning design experts, the quality of digital portals of learning resources, from the aspect

of the quality of learning materials, the majority are in the Valid qualification (94.20%).

Table 4. Rating Scores of Digital Learning Resources Portals by Learning Design Experts.

Number	Aspect	Average	Criteria
1	Component	0.92	Valid
2	Learning objectives	0.92	Valid
3	Learning materials	0.97	Valid
4	Learning strategies	0.96	Valid
5	Learning Evaluation	0.92	Valid
6	Learning Resource Strategy/Learning Portal	0.97	Valid
	Mean (average)	0.94	Valid

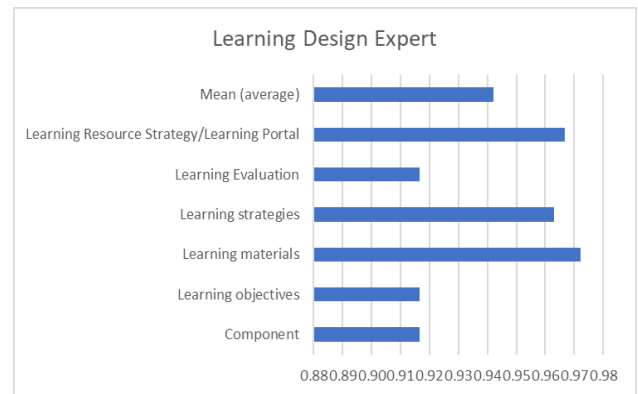


Figure 2. Diagram of the average learning value test

3. Learning Media Expert

This assessment is also carried out to obtain information that will be used to improve the quality of the digital portal of learning resources for CNC machining engineering courses for students majoring in odd semester mechanical engineering education. The results of the validation in the form of scores obtained in the form of assessment of the components of the digital portal of learning resources on the quality of learning media can be seen in Table 5.

According to learning media experts, the quality of digital portals of learning resources, from the quality aspect of learning media, the majority are in the Valid qualification (94.52%).

Table 5. Learning Resources Digital Portal Assessment Score by Learning Media Experts.

Number	Aspect	Average	Criteria
1	Access and navigation	0.90	Valid
2	Portal Interfaces	0.98	Valid
3	Learning Component	0.96	Valid
4	Appropriateness of the choice of learning resource portal components	0.90	Valid
5	The attractiveness of the portal of learning resources	1.00	Valid
	Mean (average)	0.95	Valid

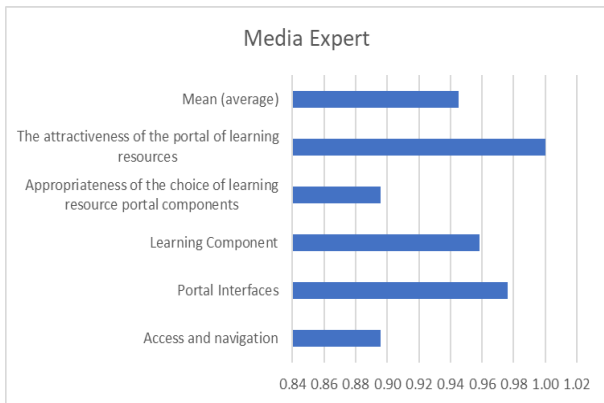


Figure 3. Diagram of the Average Test Value of Learning Media Experts

The following summarizes the results of the average percentage of assessment results on digital portals for learning resources for CNC machining engineering courses by material experts, instructional design experts, and learning media experts, which can be seen in table 6 below.

Table 6. Summary of digital portal assessment scores for learning resources for CNC machining techniques courses.

Number	Respondents	Average Percentage	Criteria
1	Material Expert	91.67%	Valid
2	Media Expert	94.52%	Valid
3	Learning design expert	94.20%	Valid
	Average	93.10%	Valid

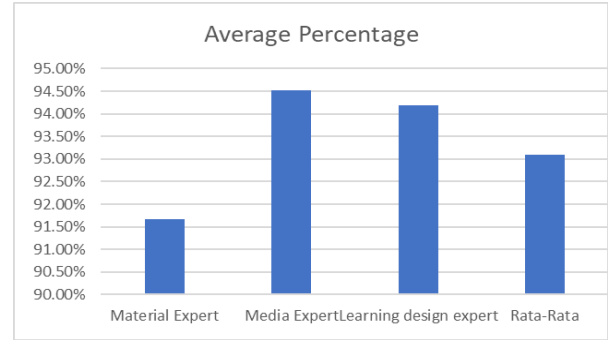


Figure 4. Summary diagram of the average assessment score of the digital portal learning resources for the CNC machining engineering course

4. Practicality Test

The results of the practicality test of the digital portal learning resources for the student CNC machining engineering course were carried out through a student response questionnaire showing the level of practicality with a percentage of 95.8% (entering the practical category). The digital portal for learning resources for CNC machining engineering courses is in the practical category, meaning that the digital portal for learning resources for CNC machining engineering courses makes it easier for students to understand the material for CNC machining engineering courses.

Table 6. Practicality test score for digital portal learning resources for CNC machining engineering courses

Number	Aspect convenience	Average (%)
1	convenience	96.6
2	time required	94.2
3	The Attraction of Portal-based Learning Resources	96.7

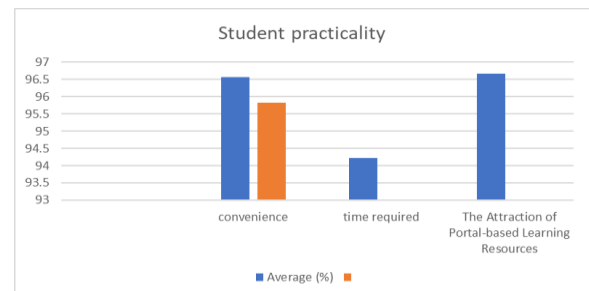


Figure 4. Diagram of Average Practicality Test Scores digital portal learning resources for CNC machining engineering courses student responses

4. CONCLUSION

Based on the results of the research and discussion, it can be concluded that the digital portal as a learning resource for CNC machining engineering courses is feasible and practical to use in achieving student learning goals in the CNC machining engineering course in the Mechanical Engineering Education Department, Faculty of Engineering, Medan State University.

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Development of Interactive World History Big Book Application Based on Big Data as a Digital Learning Source for History Education Students

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Abstract: This research is motivated by the need for an Interactive World History Babon Book Application as a big data-based digital learning resource that can be accessed by students of the Department of History Education from all over the country. This application is needed to answer the challenges of Education in the Industrial Revolution Era 4.0 and the Independent Learning Curriculum of the Independent Campus. In learning world history/spatial history, lecturers and students usually only use printed teaching resources whose content is not relevant to the CPL-CPMK Department of History Education FIS UNIMED. This is because the currently available baboon printed books only contain limited material about the history of human civilization with a limit of years in the 20th century, while in the 21st century there have been drastic changes in culture and civilization experienced by humans, coupled with the outbreak of a pandemic that has plagued humans. also change the pattern of human life habits. Then the use of the interactive world history baboon book application will make it easier for students of the History Education Department to explore other learning resources in the form of multimedia such as audio, video, animation, photos, graphics, etc. In addition, the application will give students access to historical archives from the KITLV, ANRI, National Library sites, to the latest scientific articles through the national.international Journal links that will be available on the application. Therefore, research on the development of the big data-based Interactive World History Babon Book Application that is connected to it is important to do. As for the formulation of the problem, among others: 1) How to develop an interactive World History Babon book application based on Big Data as a digital learning resource for History Education Students in the Merdeka Belajar Kampus Merdeka Curriculum? 2) How is the Effectiveness of the Big Data-based interactive World History Babon book application as a digit.

Keywords: Development, Babon book, World History

1. INTRODUCTION

The Independent Learning Campus Independent Curriculum is one of the strategic policies/programs of the Minister of Education and Culture in improving the quality of Indonesian human resources through higher education in facing global challenges. Through Regulation of the minister of education and culture No. 3 of 2020 it is explained that every university is obliged to facilitate students in strengthening competencies by providing opportunities to take learning outside the study program at the same university and/or taking learning in the same study program at a different university. In response to this program, since the 2019/2020 FY, Medan State University as an A-accredited PT (SK BAN-PT No.2988/SK/BAN-PT/Akred/PT/XII/2016) has also opened up the widest opportunities for students to carry out This policy is carried out through several student exchange programs such as Permata Sakti, Permata Sari, Internships, etc. The Ministry of Education program also provides a stimulus for the State University of Medan to optimize distance learning to accommodate the needs of MBKM in conducting online lectures using learning platforms such as SIPDA, GAFE (Google Application For Education), Zoom, etc. These platforms are certainly very much needed by lecturers and students in distance lecture activities at MBKM, especially during the pandemic.

To optimize classical, blended, and distance learning at MBKM, in addition to use the learning platform provided by the State University of Medan, every lecturer certainly needs to develop interactive digital learning materials as an alternative to printed teaching materials. Interactive digital teaching materials are learning resources that contain complete teaching materials enriched with multimedia facilities such as audio, video, animation, photos, graphics, journal web links, etc. These teaching materials allow students from all over the country to be able to obtain relevant learning resource applications with smartphones based on Android and iOS via Google Play and the App Store, so that classical, blended, long-distance or full-online history learning can run more effectively, flexibly and efficiently. Quantitatively, these interactive digital teaching materials are rare in the Faculty of Social Sciences, State University of Medan, especially in the Department of History Education. [1]

The Department of History Education is one of the A-accredited departments (SK BAN-PT No. 1161/SK.BAN-PT/Akred/S/VII/2016) within the FIS UNIMED environment that implements the MBKM curriculum in accordance with the Rector's Regulation No. 0362/UN33/PRT/2020 concerning Freedom of Learning. The MBKM curriculum certainly requires every Lecturer in the Department of History Education FIS UNIMED to be able to develop PBM activities

both offline, blended learning, and fully online as an adaptation of the Industrial Revolution 4.0 in the world of education. Especially during the implementation of distance learning (PBJJ) as a result of the Covid-19 pandemic in the MBKM era, fully online learning is a mandatory solution in the implementation of PBM activities. In addition, to maximize the Merdeka Learning lecture program that allows History Education Department students from other universities to come to join and attend lectures at the Department of History Education, Faculty of Social Science UNIMED, we need an application of interactive digital teaching materials that can be used effectively, flexibly and relevantly to the learning outcomes. Department of History Education Faculty of Social science UNIMED. That is the application of teaching materials that can be accessed easily using smartphones by all History Education students throughout the country who take lectures both offline, blended learning, and fully online at the Department of History Education FIS UNIMED. [2]

The big obstacle faced in lectures at the Department of History Education FIS UNIMED in the RI 4.0 era and the MBKM curriculum, one of which was the absence of digital baboon books that were up to date and relevant to the CPL-CPMK Department of History Education FIS UNIMED. Especially for the group of world history courses or so-called spatial histories such as American History, European History, African History, Asian History, and other spatial history courses. The world history baboon book is available in the market and currently is a printed/non-digital baboon book by Arnold Toynbee which was reissued in 2017 which is a reproduction of the baboon book that was published in 1939 ago. (Ponting, 2007) This means that the content of the material contained in the printed baboon book only reaches 20th-century historical studies (not up to date), and even then with the relatively limited content of spatial history material and is not in accordance with CPL and CPMK on the MBKM Curriculum that has been formulated by the Team Department of History Education so that these teaching materials cannot meet the needs of Lecturers and Students for world history teaching materials that are valid and relevant to the CPL-CPMK.[3]

Therefore, like the previous description, an interactive digital Baboon Book or World History Ledger application is needed to help optimize the competence of students of the History Education Department towards the materials in the World/Spatial History course class, so that each CPL-CPMK can maximally be achieved. In this case, research on the development of digital teaching materials in the form of an interactive World History Ledger application can be a novelty and something very important to do to answer the challenges of Higher Education in the RI 4.0 Era and Independent Learning to support Medan State University to become The World-Class University in the future. [4]

2. METHOD

The method used in this research is the research and development method. A development research method is a method used to produce certain products, and test the effectiveness of these products (Gooch, 2012:407). Research and Development is a process or steps to develop a product or improve existing products, which can be accounted for. [5]

3. RESEARCH RESULT

The big data-based world history baboon book application developed by the author was validated by two experts, namely: material experts and media experts. Validation is carried out on the content or material (concepts and facts) and teaching (concern for the formation of attitudes and skills) by material experts. Presentation (systematics and image illustrations) by media experts, as well as students of History Education Class C Reg 2019 as a product test of the big data-based world history Baboon Book Application. [6]

Material Expert Validation

Material validation includes material coverage, material systematics, and presentation. The results obtained from the first stage of validation can be seen in Table 1.

No	Item	Score	Max Score	Presentage	Criteria
1	Content Eligibility	16	20	80	Eligible
2	Serving Eligibility	4	5	80	Eligible
3	Language	3	5	60	Enough/Nearly
4	World history material approach	4	5	80	Eligible
Total				27	
Max Score				35	
Presentage				77,1%	
Criteria				Eligible	

The results of the material expert assessment in Table 1 show that the validation of the material expert is 77.1% with proper criteria. Aspects of content quality with an average percentage of 80% with appropriate criteria, aspects of presentation feasibility get a percentage of 80% with appropriate criteria, in the language aspect a percentage of 60% is obtained with fairly decent criteria, and aspects of the assessment approach in the American History Course get a percentage by 80% with proper criteria. [7]

Media Expert Validation

The media expert validation aims to test the big data-based world history Baboon Book Application using the Flipbook application. The results of the media validation data can be seen in Table 2.

No	Indicators	Score	Max. Score	Presentage	Criteria
1	Size	25	30	83	Very Eligible
2	Layout Design	48	50	96	Very Eligible
3	Content Design	38	40	95	Very Eligible
Total				111	
Max. Score				120	
Presentage				92.5	
Criteria				Very Eligible	

The total value of the media expert validation on the teaching material size indicator is 25 with a maximum score of 30 so that the percentage value is 83%. The number of validation values on the layout design indicator is 48 with a maximum score of 50 so that a percentage of 96% is obtained. While the number of validation values in the content design is 38 with a maximum score of 40, so the percentage value is 95%. The results of the media expert's design validation were declared very feasible. The total media validation score is 111 with a maximum score of 120, so the overall percentage of media experts is 92.5% with very decent criteria. [8]

Product Trial

Implementation is carried out after being declared feasible by material and media expert validators. Furthermore, the implementation will be tested on students of one of the 2019 Regular C classes in the American History Course at the UNIMED History Education Department, totaling 34 people. After students see and use the big data-based world history baboon book application, they will then give an assessment of the product by filling out a response questionnaire following the existing statements.

Teaching material products that have received proper recommendations from material experts and media experts have met the requirements to be tested in the field. The average score obtained in the limited field test, wider field test, and operational test were 4.19, 4.26, and 4.14, respectively, with good, very good, and good categories. The results of the analysis of student assessment scores for each criterion and indicator are described in the table below. [9]

Criteria	Indicator	Item	Item Number	Field Test Average		
				Small/Limited	Large	Operational
Material delivery	Material Interest	2	1,2	4,33	4,08	3,97
	Benefits for students	1	3	4,00	4,17	4,16
	Contextualitiy	1	4	3,67	4,50	4,21
	Material summary	1	5	5,00	4,17	4,26
	language	1	6	4,33	4,00	4,11
Media delivery	Size	2	7,8	4,16	4,25	3,94
	Convenience	1	9	4,33	4,67	4,16
	Color	1	10	4,33	4,17	4,37
	Letter	1	11	3,67	4,33	4,32
	Illustration	1	12	3,67	4,50	4,11
	Material content	2	13,14	3,67	4,00	4,16
	Media use	3	15,16,17	4,44	4,22	4,14
	Technical quality	1	18	4,33	4,83	4,26
Average				4,19	4,26	4,14

The results of student assessments in terms of material presentation (student assessment points numbered 1-6) in the limited test obtained an average score of 4.28, meaning that the presentation of material in the developed teaching materials was very good. The indicators assessed include the attractiveness of teaching materials, benefits for students, contextual materials, summary of materials and use of language with a score of 4.33 each; 4.00; 3.67; 5.00; and 4.33. Meanwhile, in terms of presentation of teaching materials (student assessment points number 7-18) an average score of 4.14 means that the teaching materials developed are good. Assessment indicators include shape and size, ease of use, choice of color, use of letters, illustration images, content of teaching materials, usefulness of teaching materials, and technical quality with a score of 4.16 each; 4.33; 4.33; 3.67; 3.67; 3.67; 4.44; and 4.33. [10]

The results of student assessments in terms of material presentation (student assessment points numbered 1-6) in the broad test obtained an average score of 4.17, meaning that the teaching materials developed were good. The indicators assessed include the attractiveness of teaching materials, benefits for students, contextual materials, summary of materials and use of language with a score of 4.08 each; 4.17; 4.50; 4.17; and 4.00. Meanwhile, in terms of presentation of teaching materials (student assessment points number 7-18) obtaining a score of 4.31 means that the product of teaching materials developed has been very good. The assessment indicators include shape and size, ease of use, choice of colors, use of letters, illustration images, content of materials, usability of teaching materials, and technical quality with a score of 4.25 each; 4.67; 4.17; 4.33; 4.50; 4.00; 4.22; and 4.83. [11]

The results of student assessments in terms of material presentation (items number 1-6) in the operational test obtained an average score of 4.11, meaning that the teaching materials developed were good. The indicators assessed include the attractiveness of teaching materials, benefits for students, contextual materials, summary of materials and use of language with a score of 3.97 each; 4.16; 4.21; 4.26; and 4.11. Meanwhile, in terms of presentation of teaching

materials (student assessment points number 7-18) a score of 4.15 means that the material developed is good. Assessment indicators include shape and size, ease of use, choice of color, use of letters, illustration images, content of material, usability of teaching materials, and quality of technique with respective scores. [12]

With the results of obtaining such a score, the teaching material product is feasible in terms of student assessment by referring to the provision that teaching materials are declared eligible if the minimum score calculation is included in good criteria. [13]

The results of observations made in the three stages of the field test showed that the application product developed in the trial stage seemed able to attract students' interest in learning. After the teaching materials were distributed to students, the students seemed enthusiastic about using the application product. Student interest in the world history baboon book application is a good symptom to improve student learning achievement. Initially, students felt less interested in world history material because it was considered boring and not contextual. The application developed here can act as an alternative source of student learning that is more interesting than just reading the grand narrative literature so that through this teaching material students have alternative learning resources besides the literature they usually use. Of the three stages of field trials, no revision process was carried out on the developed application product. During the field trials, no significant obstacles were found that required revisions. This is in line with the opinion of Giroux (2005: 426) that product revisions are carried out if there are deficiencies and weaknesses. [14]

Effectiveness Test

After the big data-based baboon book application is used by lecturers in the American history learning process, the next step is to see how effective the product is through learning outcomes tests on 34 Regular C class history education students. The following are the results of student learning tests.

Students	Score	Completeness
1	70	complete
2	70	complete
3	94	complete
4	95	complete
5	97	complete
6	89	complete
7	97	complete
8	90	complete
9	97	complete
10	98	complete
11	97	complete
12	73	complete
13	95	complete
14	97	complete
15	90	complete
16	96	complete
17	97	complete
18	83	complete
19	89	complete
20	89	complete
21	90	complete
22	90	complete
23	89	complete
24	89	Complete

25	90	complete
26	91	complete
27	92	complete
28	93	complete
29	92	complete
30	90	complete
31	92	complete
32	92	complete
33	93	complete
34	90	complete
Average		90.47

Based on the table above, the average score of student learning outcomes is 90.47 with a total of 34 students completeness. The average score obtained by students who have been percentage indicates that the completeness of the learning outcomes test obtained by students is 100%. This means that 100% of students have met the threshold value, so it can be concluded that this media is very effectively used in the learning process. [15]

4. CONCLUSION

The development of the big data-based world history baboon book application can increase students' theoretical understanding and interest, especially in spatial history material. The results obtained indicate that based on the results of the material expert validation, the appropriate criteria were obtained with an average of 77.1, while the media expert validation obtained very feasible criteria with an average of 92.5. The last stage is the effectiveness test that can be obtained based on student learning outcomes tests, obtained an average of 90.47 which means that the big data-based baboon book application is effectively used in the spatial history learning process.

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Digital Archiving and Preservation of Cancer Records: Case of KNH/UoN Department of Pathology

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Abstract: Cancer is considered to be 3rd leading killer and 2nd among non-communicable diseases in Kenya Mutinda J. (2019). Ferlay, et al (2013) noted there are about 37,000 new cases of cancer annually and annual mortality rate of 28,000. This indicates cancer records rapidly accumulate over time and more resources are needed to collect and manage cancer-related data. KNH/UoN Department of Pathology have for a long time kept their records using a paper-based system.

Objective of the study was to review current record keeping system including the process of preserving, storing and retrieving cancer records and the challenges faced, develop a model to guide the archival of locally available cancer paper-records and a web based prototype to preserve and avails this information to a wide range of stakeholders.

The study used descriptive research design involving 22 participants. Random sampling technique was used to select respondents among the sampled population. The intervention prototype was developed using the RAD methodology.

It was noted that cancer patient data were captured through standard forms/books (86% of the respondents) and stored in standard forms/books (71% of the respondents). 57% stated that identification of record and documenting was done based on LAB number. ICD 10 Coding system was not fully implemented as many forms had old coding format. 77% of the participants stated that the inability to track patient records with ease as a challenge and lack of technology in records management as a potential security breach and damage of records.

Findings presented a strong case for this research study where, upon prototype developed, there was concurrence among the respondents that the developed solution would be of significant to enhance cancer records management in the department and improving the healthcare service delivery process. This model can also be used to preserve other similar medical paper documents.

Keywords: Digital preservation, Digital Archive, Digital Record, Electronic Medical Record (EMR).

1. INTRODUCTION

Worldwide, cancer beats HIV, malaria and tuberculosis combined, as the leading cause of death. Mutinda J. (2019), estimates that 70% of the world's cancer burden is in Low- and Middle-Income Countries (LMICs). In Kenya as of 2019, cancer was the 3rd leading killer and 2nd among non-communicable diseases. This translates to roughly 7% of Kenya's overall mortality rate. Ferlay, *et al* (2013) reported that there are about 37,000 new cases of cancer annually, with an annual mortality rate of 28,000.

The mode of record keeping in a health institution could help advance or bring it down in equal measure (Muhaise, *et al.*,

2019). Roughly 85% of the world population lacks quality cancer registration (Bray, *et al.*, 2015). Kenyatta National Hospital (KNH) and the University of Nairobi (UoN) Pathology Department have for a long time kept their records using a paper-based system. Any kind of paper records tends to be unreliable and tedious to maintain since they could be damaged or lost. A lot of time is lost digging into records which are probably missing and/or misfiled (Johnston, *et al.*, 2005), which is uncondutive to the functioning of the health institution (Benfell, *et al.*, 2002). The gravity of the cancer problem in Kenya lacks adequate quality data to inform

decision making. In order to effectively manage cancer, an evidence-based approach is needed which can only be derived from the foundation of accurate and complete data provided by digital cancer records (Forsea, 2016). These digital registries become a crucial source of objective information concerning the number of new cases of cancer, cancer-related mortalities, and types of cancer, geographical spread of incidences, the number of people living with cancer, and the number of cancer survivors in the populations they cover. Health institutions are then able to make informed assessments of the current cancer situation and estimate future trends in the cancer burden within different populations and regions, thus implementing effective cancer control plans (Coebergh, *et al.*, 2015).

This study therefore purposed to digitize Kenyatta National Hospital (KNH) and University of Nairobi (UoN) Department of Pathology cancer records as a way to secure the records and minimize the risk of loss or damage. This approach can also be replicated for other paper based health records such as x-ray reports, lab reports etc. The primary motivation for this initiative was to avail the cancer records on a digital platform thus opening up the possibilities of software-based data analysis and digital access to the records from various locations by healthcare researchers, practitioners and medical students.

2. OBJECTIVES

To review the current record keeping system, develop a model that will guide in digital archival of locally available cancer paper-records and a web based prototype that preserves and avails this information to a wide range of stakeholder. For this study, we focused on the KNH/UoN Department of Pathology records.

2.1 The specific objectives:

1. To evaluate the current cancer records management practices of the KNH/UoN Department of Pathology.
2. To find out the challenges towards the digital archival of cancer records and assess the digital archival readiness of the KNH/UoN Department of Pathology.
3. To review related Models and Frameworks that aid in digital archival and preservation of health records.
4. To design, develop and implement a prototype for digital archival platform for cancer records. This platform will provide basic statistics and search functionality.

3. METHODS

This research study involved three key phases: Phase 1 was the pre-study. This involved investigating the challenges and processes in the current cancer records management practices of the KNH/UoN Department of Pathology. Questionnaires and interviews were used to gather data during this exercise. During the second phase, the first step was to gather system requirements from the core users before

proceeding to the ICT intervention development. A web application that stored detailed information about cancer patients (such as demographics) and the initial treatments they received (e.g. histopathology report form) was developed. Authorized users were allowed access to these records and retrieved information regarding a patient's medical history (e.g. lab results, screening information, and any history of a previous cancer).

The third phase was to evaluate the developed ICT intervention.

Scope of the study

The research was carried out at the KNH/UoN (Department of Human Pathology). The research mainly involved health science professionals, record clerks, researchers, doctors, and medical student's admin. The project aimed to provide an application prototype that facilitated digitized cancer record keeping in health institution.

3.1 Pre-study

This phase was conducted as the first objective of this research, in order to inform about the challenges and processes in the current cancer records management practices of the KNH/UoN Department of Pathology. We did a thorough investigation through literature review and involvement of a significant number of participants who included health science professionals, record clerks, researchers, doctors, and medical student. Some of the data gathered from literature included a review of existing applications and documentation regarding cancer records .Some of the related work reviewed included:

3.1.1 Kenya Health Policy 2014–2030

The Kenya Health Policy, 2014–2030 gives directions to ensure significant improvement in overall status of health in Kenya in line with the Constitution of Kenya 2010, the country's long term development agenda, Vision 2030 and global commitments. The second objective of Kenya Health Policy 2014-2030 is to halt and reverse the rising burden of non- communicable conditions. Cancer disease is one of non-communicable condition. These non-communicable diseases represent an increasingly significant burden of ill health and death in the country.

These represented 50% to 70% of all hospital admissions and up to half of all inpatient mortality (Kenya Health Policy 2014–2030).

3.1.2 Medical Records at KNH

KNH receives a very large number of patients. According to (Cheruiyot 2013), patient records especially in the KNH Private Wing are maintained in manual files and stored in registries for as long as a patient remains admitted there. The records are later transferred to a section of the main registry after the patient has been cleared and discharged.

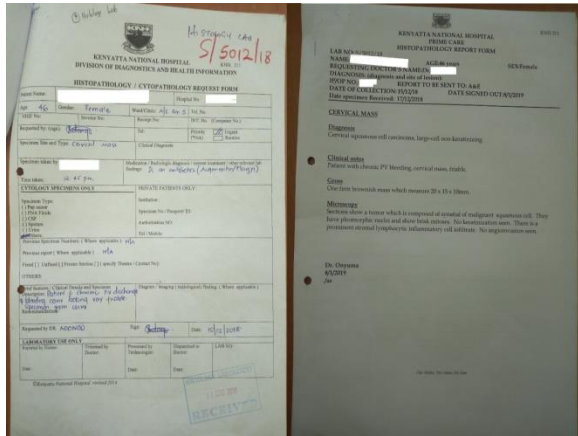


Figure 1: Histopathology Report Forms (Source: KNH/UoN Dept. of Pathology)



Figure 2: A Snapshot of Record Folders at KNH (Source: KNH/UoN Dept. of Pathology)

Cheruiyot (2013) observed that the patient files are stored in lockable cabinets accessible only to serving medical staff.

3.1.3 KNH's ICT Master Plan (2012)

KNH's ICT Master Plan was prepared in line with the Vision 2030 goal for the health sector to provide equitable and affordable health services to all Kenyans. Projects within The ICT Master Plan included digitizing all of KNH's manual records (approximately 40 Million paper documents) from the past 10 years onwards. A few areas were highlighted as priorities for automation including the patient registration and billing system. (Cheruiyot, 2013).

3.1.4 ICD-10 Coding system

The ICD is the international standard diagnostic classification for the entire general epidemiological, health

management purposes and clinical use. This ICD-10 is used to classify and to record diseases and other health problems reported on many types of health and other records like death certificates. Also ICD-10 enables storing and retrieving diagnostic information for epidemiological, clinical and quality purposes (Valerie J et al 2012). However according to (Kiongo 2015) the coding and reporting of procedures and diseases in

Medicine at KNH is not satisfactorily done as per the WHO guidelines in their publication about ICD-10.

3.1.5 Benefits of Digitizing Paper Records

Enables all data to be stored in a single location (Dollar, 2002). They can be quickly accessed and retrieved (Bates, et al., 2003). Enhance communication and engagement between doctors. (Richards, et al., 2012). Improved quality of health care. (Menachemi, et al., 2011). Ensures scalability and reliability of the records (Forsea, 2016).

3.1.6 National Cancer Institute

National Cancer Institute (NCI) had noted that in Kenya in Kenya, cancer is the 3rd leading cause of death after cardiovascular and infectious diseases. The annual incidence of cancer was estimated at 47,887 new cancer cases, with an annual mortality 32,987 in 2018. NCI also noted that prostate, Oesophageal and colorectal are the leading cancers on Men, while breast, cervical and oesophageal cancers are most common women. Oesophageal cancer is the leading cause of cancer mortality in the country Kenya contributing 13.2 % (4,351 deaths). Cervical cancer is the second leading cause of cancer death contributing 10% (3,266 deaths) while breast cancer comes in third at 7.7% (2,553 deaths). (GLOBOCAN, 2018)

3.1.7 Frameworks and models reviewed

3.1.7.1 Implementation model of CanReg5 – (Cancer Registry)

National Agency for Research on Cancer (IARC) of WHO used CanReg model to develop a system that help nations implement their own cancer registration (Pardamean, et al., 2015).

The model enables capturing of cancer records in hospitals with limited computer and network support. Unit Cancer Registration (UCR) requires data entry staff and a personal computer to run this CANREG 5.

From this model the researcher used Unit Cancer Registration (UCR) component that was used in data entry for cancer patients in a unit e.g. demographics, symptoms, diagnosis, treatment plans.

3.1.7.1 A Digital Transformation Business Model.

Prem (2015) wrote a paper to study the changes in business model innovation brought about by the transformation to

digital technologies. This model aims to represent empirical objects and empirical characteristics of phenomena businesses experience in the process of digitization. It models particular components of business models and assumes underlying causality in the gap between components following changes in any given component. The model connects changes in business model components and their linkages with the precise characteristics of digital technologies and this was the basic component used from this model.

3.1.7.3 E-health readiness framework from electronic health records perspective.

This framework is concerned with three domains relevant to E-Health readiness practitioner, organization and public. It highlights the key elements that are required for successful E-Health initiatives. This framework is based on multiple perspectives which includes organizational such as ICT infrastructure, Practitioner such as user access and public such as government regulation. One of the pre-requisite of this framework is Information communication technology (ICT) architecture/ infrastructure and is one of the components that was used by the researcher as an essential ingredient to the undertaking of E-Health initiatives.

3.1.7.4 Informatics infrastructure framework to support data use KEMRI

In this Framework data are collected by trained clerks and pre-programmed field validation rules in the REDCap tool are used to check data quality as it is entered. Then codes that are used for running on- site checks on daily basis are auto generated through metaprogramming process and also using statistical software that is installed in hospital site's computers. It then also cleans and recodes data to enable indicator measurement and reporting. These data are used also to create timely reports for health facilities that have traditionally had no access to daily routine information that includes process as well as outcomes for their patient. REDCap tool that was used by clerks to check data quality, was one of the component that use in this study since it could also generate reports from the stored records.

Data collection

The data was gathered using open ended and closed questionnaires and interviews. The study targeted 28 respondents drawn from KNH/UoN facilities. The targeted population of 28 people was the actual number of people in KNH/UoN in the unit that was the main focus for this study. According to research findings 22 participants responded to the researcher whereas 6 targeted participants did not respond to the researcher. The participants include 12 researchers (medical students), 3 Policy makers, 5 pathologists and 2 Record clerks from KNH/UoN facilities.

3.2 Prototype development

3.2.1 Proposed solution

Figure 2 illustrates the researcher's conceptual perception of the system design. The design was based on literature reviewed, and the researcher's understanding of the stipulated current process of capturing, storing, retrieving and disseminating cancer records

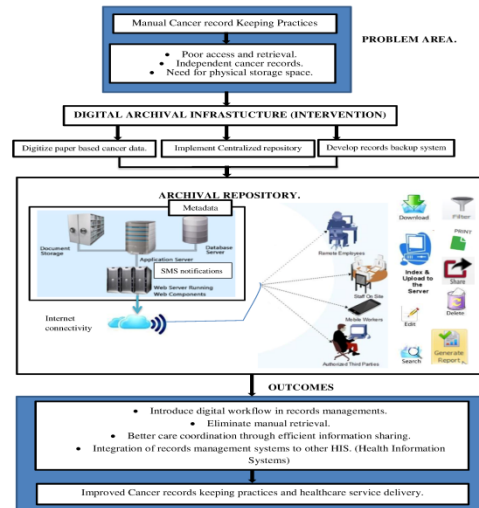


Figure 3: Conceptual Model.

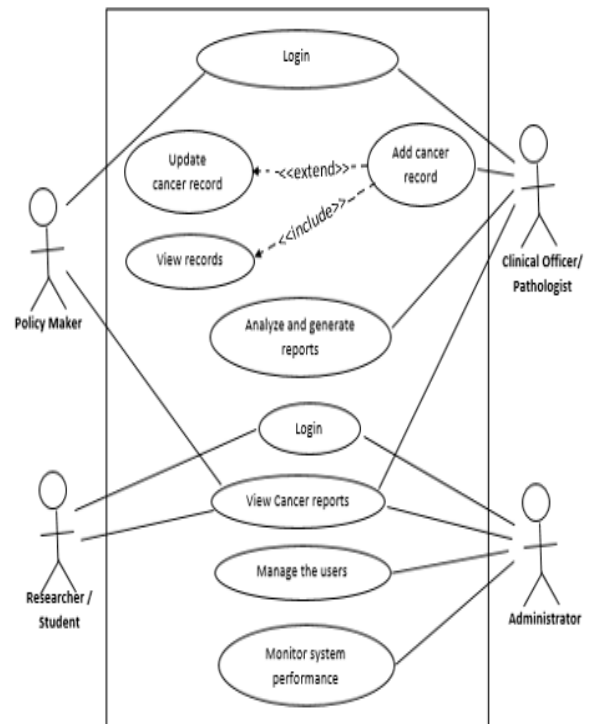


Figure 4: UML Diagram

3.2.2 Overview of the system developed

The system basically stored detailed information about cancer patients (such as demographics) and the initial treatments they received (e.g. histopathology report form). Authorized users were allowed access to these records and retrieved information regarding a patient’s medical history (e.g. lab results, screening information, and any history of a previous cancer). The ICT intervention was a web based application that improved records management for cancer cases at the KNH/UoN Department of Pathology. The Proposed system was a responsive website hosted and on Linux server.

The preferred methodology for the development of the prototype was Rapid Application Development (RAD).

3.2.3 System design

The prototype enforced coupling and cohesion by interlinking components (modules) where functional and non- functional requirements were key drivers in this phase. The system requirements were mapped onto the systems expected functionality.

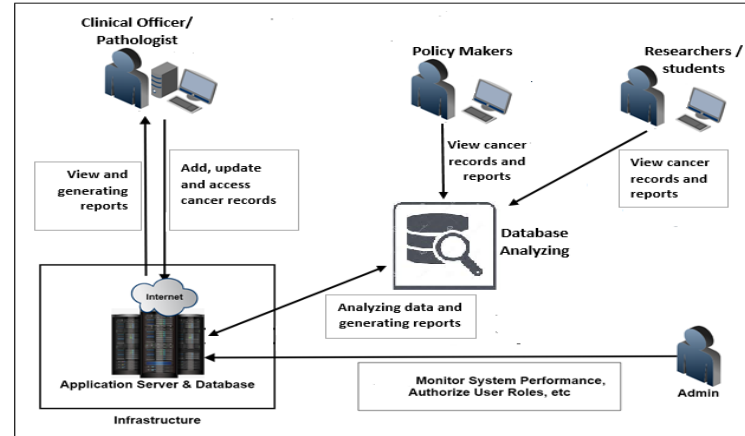


Figure 5: System Design

3.2.4 Design Decision and implementation

Based on the intervention functional and non-functional requirements, technology design decisions were made and

the system was implemented using the following technologies. (See table 1)

Table 1: Development Platform

Development Platform	
User Interface (UI)	HTML5 and CSS
Backend (Database Management System)	Microsoft SQL (Structured Query Language) Server
Hosting	Linux server
Sending password to the users through SMS	Africa’s Talking API Messaging
Scripting	Laravel 5.3 a PHP framework and bootstrap 3
Generating graphs and charts	Chart Java Script (JS)

3.3: Prototype Evaluation

This was to assess whether or not intervention / system developed worked the way it was intended to and if the user requirements were met.

conducted on interviews and open-ended questionnaires, while quantitative analysis was done on close-ended questionnaires. 22 participants from KNH/UoN Department of Pathology (12 Researchers, 3 Policy makers, 5 Pathologists and 2 Record clerks) were involved.

4 DATA ANALYSIS

This study’s main objective was to develop a model that was to guide the digitization and archival of locally available cancer paper-records and a web based prototype that preserved and availed this information to a wide range of stakeholder. As such, both quantitative and qualitative data analysis methods were perceived as the most suitable approaches for this study. Qualitative data analysis was

4.1 Socio-Demographics

Age of most of researchers was ranging 25-35 years (7/12), Policy makers was ranging 35-44 years (2/3) ,which was the same range to the pathologists(3/5). The level of education of most researchers was postgraduate (6/12), same to pathologists (3/5) .Most of the pathologist had served in the

department for 6- 10 years (3/10) meaning they understood very well the challenges affecting that department.

4.2 Capturing patient’s personal data

Record clerks and pathologists were the respondents to these questions. Record clerks were 2 in number and pathologists were 5, resulting to 7 in total.

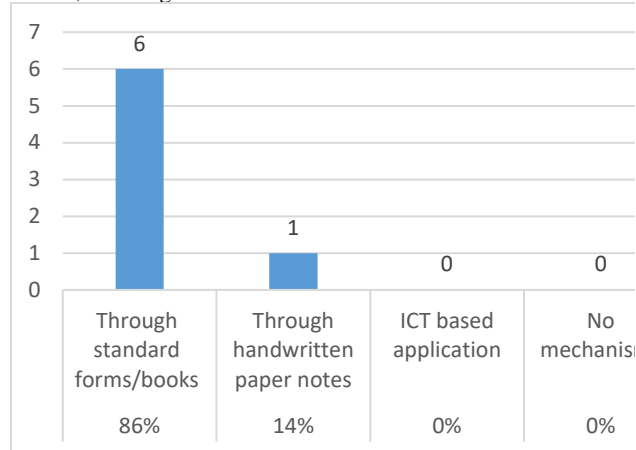
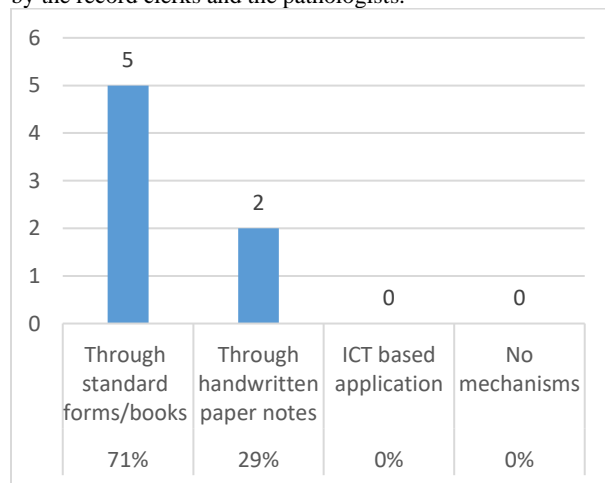


Figure 6: Capturing patient’s personal data

This clearly showed that cancer records are captured manually.

4.3 Storing of the captured cancer records

This was aiming to know how the data is stored after it had been captured from the cancer patient. It was also responded by the record clerks and the pathologists.



Having majority of the respondents reporting that data was stored using forms and books showed that cancer records still were stored manually in files and these paper records were highly prone to physical damage, duplication, and loss. Crucial patient information may as well miss when needed.

4.4 Identifying particular patient record and documenting lab reports

This helped the researcher to know the unique ways of identifying a particular patient record and how the lab reports for histology and cytology were documented.

Majority of the responses 57% (4/7) reported that Identification of patient record and documenting lab report was done based on LAB number. The LAB number contained the slide number, the report number and the year that record was stored, example of LAB number was S/5012/18. 14% of the respondents (2/7) reported that this was done using record index number, hospital number and based on Inpatient and Outpatient number.

4.5 Cancer record accessibility

This was aiming to find out how frequently cancer records were accessed by researcher/medical students and policy makers. Researchers / medical students were 12 in number and policy makers were 3, resulting to 15 in total. The kind of information that was accessed by researchers/ medical students was patient records history and lab results that helped them in their studies and in research while the policy makers had interests in information relating to cancer incidences and prevalence.

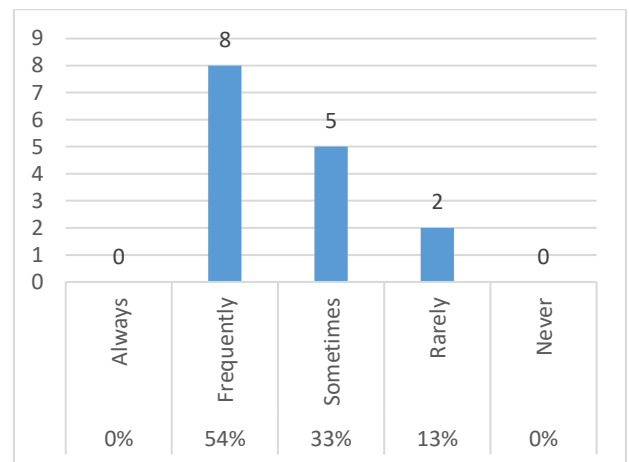


Figure 7: Cancer record accessibility

4.6 Rating of the current means of cancer record keeping.

This was responded by all the participants (22). 54 % of the respondents stated that the current processes of cancer record keeping were not at all efficient.

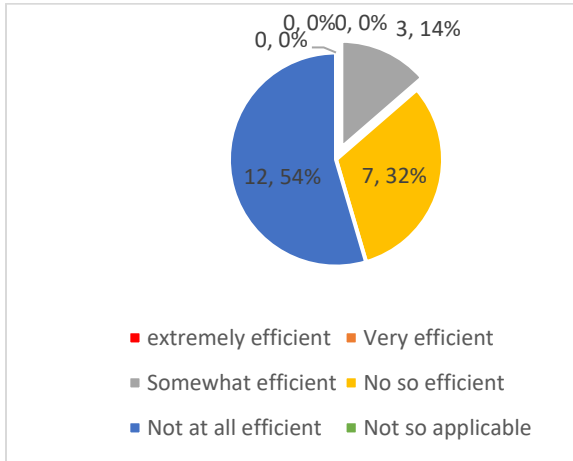


Figure 8: Rating of the current means of cancer record keeping

4.7 Challenges with the current cancer record keeping practices

This was responded by all the participants in the study (22). A big number of participants (77%) noted inability to track patient records with ease was the main problem in the current processes of storing and retrieving cancer records in KNH/UoN facilities.

Challenge	Researchers (N = 12)	Policy Makers (N = 3)	Pathologists (N = 5)	Record clerks (N = 2)	Total responses (N = 22)	Per cent (%)
Lack of clear record keeping guidelines or protocols	2	2	3	1	8	36%
Poor communication and data sharing between the different departments	0	0	5	2	7	32%
Inability to track patient records with ease	8	3	4	2	17	77%
Loss or damage of patient records	6	2	5	1	14	64%
Lack of technology in records management	8	2	4	2	16	73%

Table 2: Challenges with the current cancer record keeping practices

4.8 ICT Usage levels

This was to determine rate the level of ICT usage in the whole process of cancer data / Information record keeping.

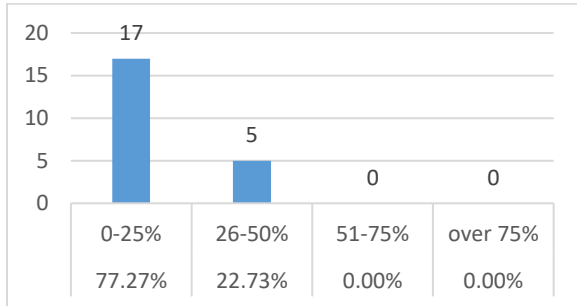


Figure 9: ICT usage levels

This indicated how manual processes were used in KNH/UoN Department of Pathology.

4.9 Challenges that hinder the implementation of digital preservation of cancer record

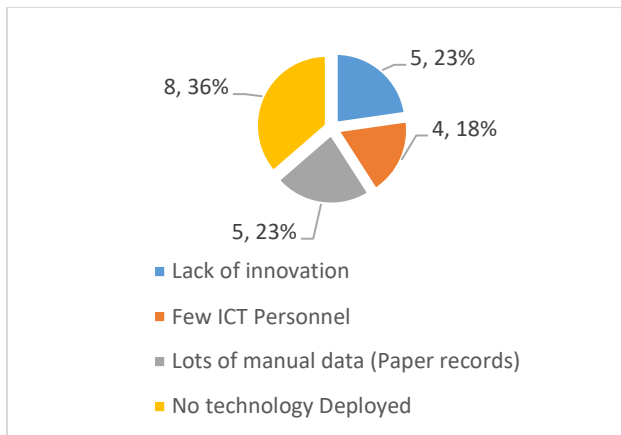


Figure 10: Challenges that hinder the implementation of digital preservation of cancer record

The aim was to determine the challenges that hinder the implementation of digital preservation of cancer record to enable distributed form of accessibility.

4.10 Opinions on what should be done to improve cancer record keeping

The participants of the study were required to give their opinions on what should be done to improve the whole process of cancer record keeping in KNH/UoN Department of Pathology.

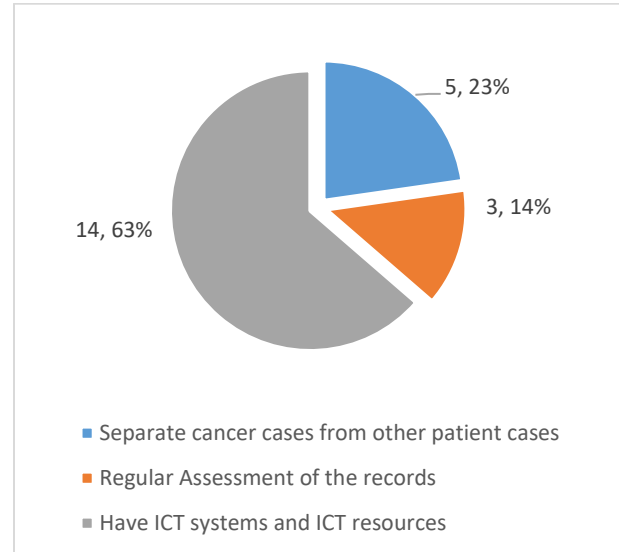


Figure 11: Opinions on what should be done to improve cancer record keeping

4.11 Recommendations of using the digital platform for capturing, storing, retrieving and preservation of cancer records

This was to determine some of the recommendation from the participants that should be incorporated to the ICT intervention to improve the process of capturing, storing, retrieving and preservation of cancer records.

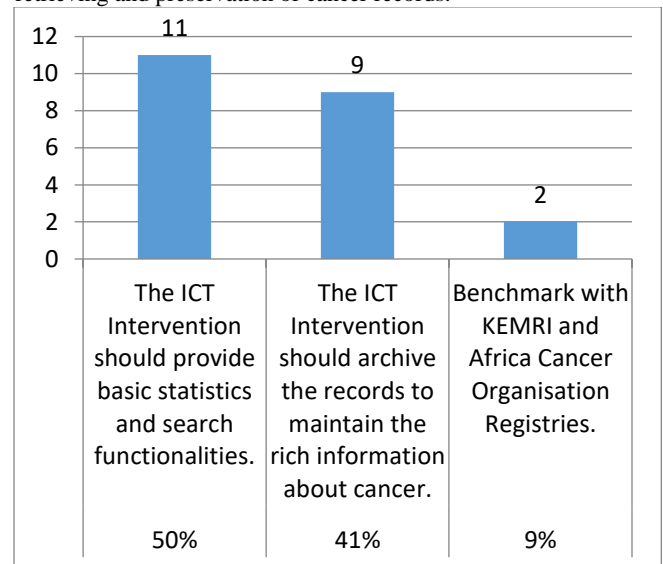


Figure 12: Recommendations using the digital platform for capturing, storing, retrieving and preservation of cancer records

5 CANCER MANAGEMENT RECORDS PROCESS MODEL

Based on the data gathered from the questionnaires and interview, we were able to understand the whole Cancer records management processes in KNH/UoN Department of Pathology. This was done to accomplish part of this study’s objective. It also assisted us in learning where to inject the proposed solution into the cancer record management processes in our area of study.

At the beginning, cancer patient record was captured manually given that is not stored in the main registry. When the cancer patient had been treated and discharged then the records were stored in main registry in a lockable cabinet. These paper records tend to be unreliable and tedious to maintain since they could be damaged or lost. A lot of time also was lost digging into records which were probably missing and/or misfiled. The records from the main registry could be retrieved when the Patient visit that facility several times for check-ups. Looking at these processes, we came up with a process model that showed where the ICT intervention of digitizing the cancer records would be applicable. The process is illustrated in Figure 13.

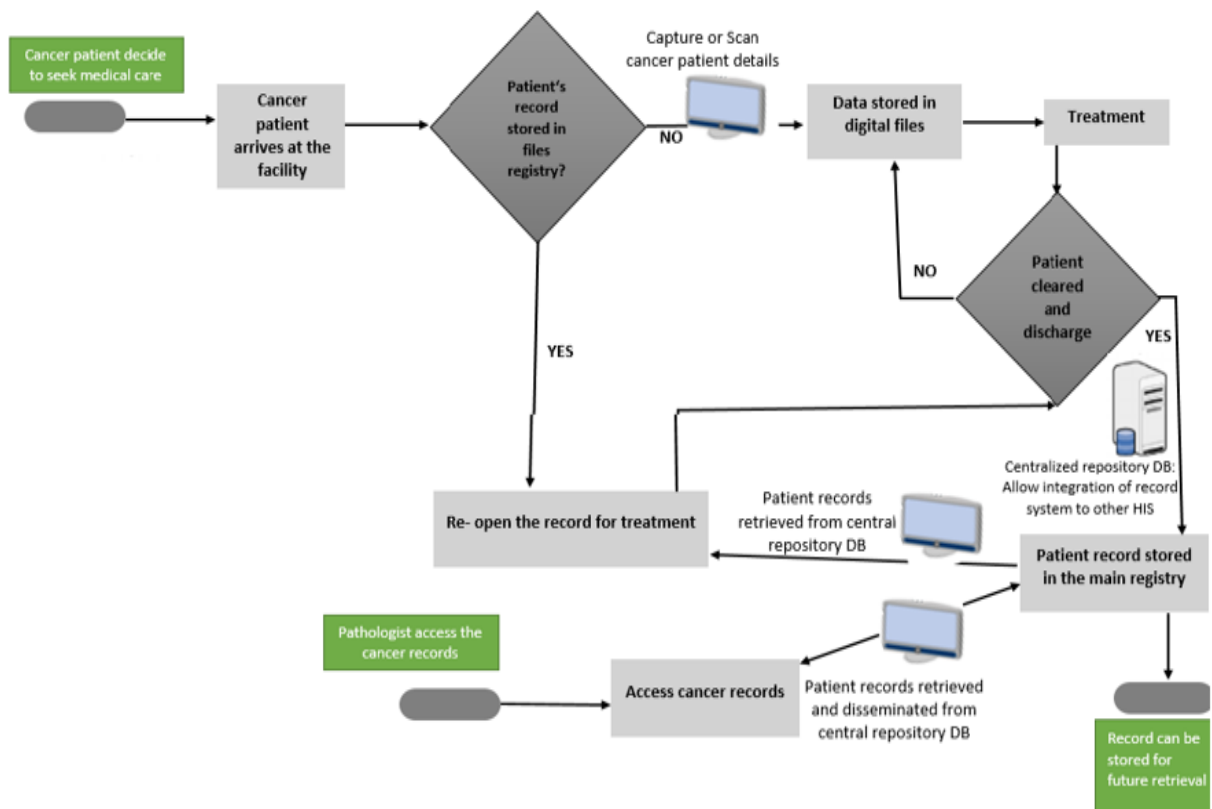


Figure 13: Cancer records management process model in KNH/UoN Department of Pathology: ICT Inclusive

6 System Evaluation results

Seven participants were used to evaluate the proposed ICT intervention: two pathologists, one record clerk, three researcher/ medical students and one policy

maker. Once the respondents had interacted with the system and had a feel of what it does, they were administered with the evaluation questionnaire.

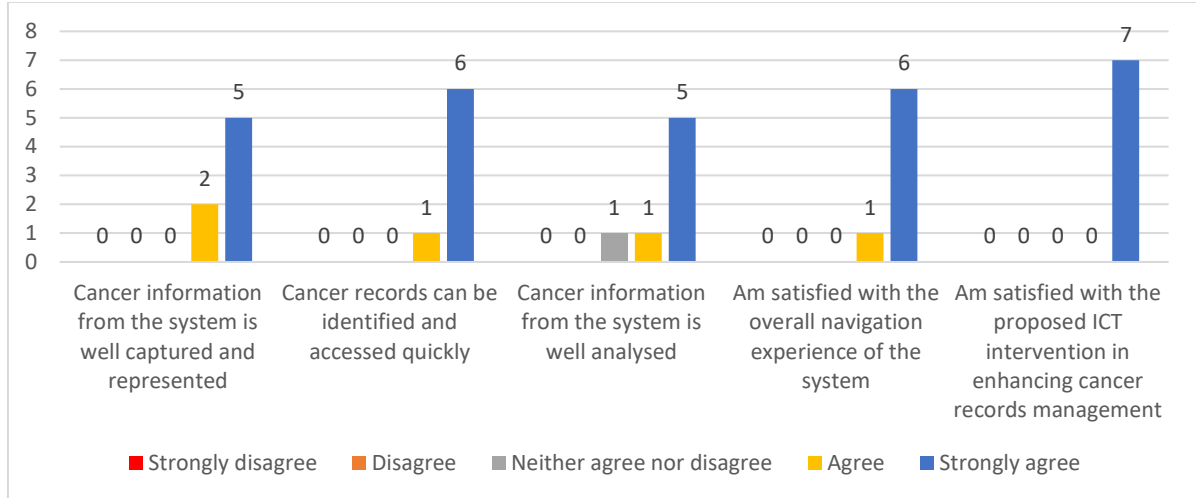


Figure 14: System evaluation

7 Strengths of the system

- It would enable managing of escalations and follow-up on patients more efficiently; for better patient-centric care, and also have immediate access to treatment documentation.
- It would help in reducing manual intervention during records management
- It would help toward mitigating risks like records getting damaged, lost, mixed up and/or duplicated.
- The problem of storage space constraints would be resolved since everything was being stored digitally.
- It would improve efficiency in healthcare service delivery and productivity.

8 Conclusion

- In KNH/UON department of pathology all processes concerning cancer records remain to be done manually
 - The process of capturing and storing the cancer records are just keyed in forms (Microsoft Word) that are later printed and filled
 - Identification of the stored patient records including LAB test reports were done mainly using the LAB number instead of more advanced ways like ICD10 format.
 - Evaluation of the use of ICT in this process indicated that ICT usage was poor (0-25%).
- Inability to track patient records with ease and loss or damage of patient records are the main challenges as far as capturing, storing and retrieving cancer records is concern
- Cancer records stored in KNH/UoN Department of Pathology remain to be relevant to the researchers/ medical students and the policy makers.
- The developed system enables digitization and archival of locally available cancer paper-records in a way that preserves and avails this information to a wide range of

stakeholder and provides basic statistics and search functionality. thus improving record management for cancer cases at the KNH/UoN Department of Pathology.

9 Limitation of the study

- Access to personal medical reports from KNH/UoN Department of Pathology was a challenge.
 - Records are private and confidential and are archived in place that is and can only be accessed by authorized persons.
 - The state in which some records were in, was a challenge, they needed to be handled with care to ensure the rich information in those records were maintained.
- Research participants were recruited from one of the four units and thus the generalizability of the findings may be limited because of the sample size.
- Time constraint was also a limitation worthy of mention to get participants at their own convenient time to fill the questionnaire and respond to interview questions.

10 Recommendations for future works

- This approach can also be replicated for other paper based health records such as x-ray reports, lab reports etc. ICD10 coding system should be implemented fully to enable medical personnel track healthcare statistics.
- Respondents suggested interoperability of health information system in different health facilities should be enhanced.
 - To enable cancer records being stored on one form of database to be accessible in another form of database.
- GIS and comprehensive cancer surveillance system should be put in place to locate areas where

- many people with a different cancer cases are located.
- d) Public Health institutions should devote a substantial budget to enable technological development.
- ICT Infrastructure should be supplied and put in place and the existing ones to be upgraded.
 - Constantly train their medical practitioner to improve their technological-driven health care delivery.
- e) Population based cancer registry should be in place in most counties country wide since the available cancer data is wanting and if is preserved and distributed virtually it could assist in monitoring of the prevalence and incidence of cancer cases.
- With cloud hosting in place, these records can be encrypted and stored on offsite servers where they can only be accessed with a unique login that will decrypt them.
 - Tracking exactly who logged on with their unique ID will be in place and what they did to keep out unauthorized individuals since the records have personal information on them that is a great legal risk and needs to be protected.

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Enhancing Blood Products Sharing Among Established Blood Banks and Health Facilities through the use of ICT

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Abstract: The gap between blood supply and blood demand is a widening everyday as the population increases and it needs to be bridged. Since the amount blood donated in Kenya is below the world Health Organization’s recommendation (WHO 2015), inter-facility sharing of information relating to blood availability should be enhanced to improve sharing of available donated blood between health facilities.

The objective of the research study was to determine the current processes used when sharing blood between health facilities and there challenges and to propose coordination between blood supply and demand among health facilities and blood banks through the use of ICT .The study used descriptive research design and 22 participants (lab technicians and doctors) in different health facilities in Nairobi County participated in the study.

Results from the study indicate that in most health facilities (72%) blood demand exceeds blood supply. During emergencies when blood stocks are inadequate, most health facilities (63.6%) source the blood by requesting it from other health facilities and blood banks and mostly making these blood requests through telephone calls. The main challenge faced when using the current mechanisms is the delay in blood supply (40.9%) followed by a challenge of getting the response/feedback on time

Based on the findings it was evident that the proposed intervention will be of a great use to bridge the gap of between blood supply and demand and solving the challenges faced when sharing blood during emergencies. Rapid Application Development (RAD) system design AND Service Oriented Architecture (SOA) were applied in developing the ICT intervention. To evaluate the success of the ICT intervention, a survey was conducted in five health facilities (two level 4 and three level 3 health facilities) to evaluate the satisfaction of the health facilities when using the system.

Keywords: Blood, Blood banks, health facilities, blood sharing, ICT.

1. INTRODUCTION

Timely access to secure blood and blood products is part of the WHO’s global health agenda and global strategic priorities (WHO Regional Office for Africa, 2009). Blood is considered as a very important product in healthcare services because most surgical and emergency activities in hospitals depend on blood transfusion thus sufficient blood distribution and supply in timely manner to hospitals is most essential activities to enhancing health care (Tapko 2006).

Currently in the world the availability of integrated health care system is important in enhancing emerging medical response (Mwangi 2017). According to WHO 2015 the world is making significant steps to reduce the mortality rate caused by diseases and emergencies like accidents, however this is only being experiences in developed country hence more effort need to be enhanced in developing and undeveloped countries. Development and expansion of Information

and Communication Technology in healthcare management has been the trend in developing and innovating health solution in all the parts of the world since 21st century (Kumar 2003). Specifically, according to (GUO 2009) ICT plays a major role in managing blood donated in blood banks as well as in health facilities.

Access to safe blood in convenient time can prevent many deaths especially in developing countries. One pint of blood (450ml) can save 3 lives while teaspoon of blood can save one baby's life (Ileri 2014). For instance according to WHO 2014 almost 800 women lose their lives daily in the world due to complications of pregnancy and childbirth. 27% of these women bleed to death before, during and after giving birth. So if blood readily available in convenient time some such kind of deaths can be avoided.

Kenya acknowledged the importance of coming up with a national blood service that agrees with WHO proposals and World Health Assembly (WHA) declarations suggestions were used to make regional system of transfusion centers managed by central coordination in 1994. In the year 2001 Kenya's initial blood policy plan was established and opened the first Regional Blood Transfusion Center (RBTC) and

2. OBJECTIVES

The study aims in at developing a solution that will help to bring about proper coordination between blood supply and demand among health facilities and blood banks by enhance sharing of these blood products between them.

The specific objectives:

- i. To investigate the availability of blood in health facilities.
- ii. To evaluate current process and methods used when sharing of blood products between blood

national management office was set up in Nairobi (Kenya National Blood Transfusion Service, 2012).

In Kenya KNBTS collects, tests, process and distribute blood and blood products to all transfusing health facilities in the country. Mostly Non- government organization like Kenya Red Cross (KRC) and Hope Worldwide Kenya drives the processes of awareness, mobilizing and recruiting blood donors in Kenya. National Management of blood and transfusion services in Kenya is carried out by the Kenya National Transfusion Center at the Kenyatta National Hospital (KNH) which processes blood and make it available to the blood banks and health facilities located all over the country.

According to KNBTS report (2013) Kenya needs 400,000 units every year to be blood sufficient. However KNBTS acknowledged that it has failed to hit its target of 180,000 units as visualized in the period ending December 2017. In lieu KNBTS collected 149,000 units. Since there is increasing in demand for blood products as donor population decreases, supply chain for blood to and between health facilities should be enhanced to save lives (seifried et al 2011).

banks and health facilities and there challenges.

- iii. To design and develop a web based system that provides timely information to health facilities about the availability of blood and blood products in blood banks and health facilities
- iv. To evaluate the prototype by involving lab technicians and doctors in health facilities

Blood and blood products

The most important blood groups among more than 30 major blood group systems are blood group systems ABO and RhD when

referring blood donation and blood transfusion (Ireru 2014). The blood groups are determined on the surface of red cells by the protein known as antigen. Blood group of a person is defined by both ABO and RhD blood groups. For example a person whose ABO blood type is B and RhD is negative(-), that blood group is known as blood group B-. A person may have ABO blood group A, blood group B, blood group AB or blood group O Whereby RhD can only be positive (+) or negative (-).

According to (Repine 2006), most common blood products used for blood transfusion are Red Blood Cells (RBC), whole blood, platelets, plasma and cryoprecipitate (frozen plasma). These blood products have different shelf lives depending on the kind of the storage used (type of blood bag used and the temperature of storage area). For instance the expiry date for Red Blood Cells (RBC) depends on the type of anticoagulants and additive solution used (Rubin 2011). The shelf life of whole blood is 35-42 days, Red Blood Cells are 42 days, platelets are 5 days, plasma is 48 hours and cryoprecipitate the shelf life is up to 1 year.

Blood supply chain

According to A.F. Osorio et al (2015), blood supply chain contain the following processes ;collecting, testing, processing and distributing blood and blood products from donor to recipient. Mainly in the countries where there are regional and national systems, blood is transported between blood centers and health facilities and also between health facilities. Since there increasing in demand for blood products as donor population decreases, supply chain for blood to health facilities remain the important factor (seifried et al 2011).

ICT for blood bank management

Alfred et al (2012) indicated blood can be stored in health facilities for varying amount of time, this can be from a few days, months or even years and the unused amount of blood is returned to the blood bank. Therefore due to reserving and undeserving blood in hospitals blood banks, ICT services are needed to keep records and transfer (share) information about the balance between the blood bank and health facilities (Kendall et al 2012). In his study about blood distribution in health facilities using ICT in South Africa, Alfred (2012) found that the blood shortage in the hospitals occurred frequently. However this problem of shortage of blood can be solved by ensuring every hospital blood bank contain sufficient through monitoring effectively using ICT. Also ICT according to Alfred (2012) can be used to prevent overstocking blood in a single hospital while other hospitals run out of stock and this can enhance supply of fresh blood in case of any emergencies in hospitals.

Sharing of blood products among health facilities in Kenya

Management of blood, blood products and blood transfusion services in Kenya is carried out by Kenya National Transfusion center at Kenya National Hospital (Kenya National Blood Transfusion Service, 2012). It processes blood and distribute it to the established blood banks and all over the country. Then the blood banks avail the blood for use to the health facilities.

Guidelines recommended by KNBTS when requesting blood for blood transfusion (KNBTS 2012)

i. Only qualified doctor my order blood but when there is emergency, blood may be requested by a nurse on doctor's behalf.

ii. Urgently samples and requests must be discussed directly through the phone and the form in the laboratory should be labeled URGENT.

iii. The laboratory shall record all requests made through the phone including patient's details, the requesting doctor and the person making the phone call.

iv. The laboratory will require a sample to issue any blood component

v. When there is extreme emergency blood group O negative blood will be issued because O negative can match with any other blood group in transfusion

Related work.

Australia's online blood ordering and inventory management system

Blood products sharing in Australia is managed by a system known as BloodNet. BloodNet is a web based system which enables staff in health facilities across Australia to be able order blood and blood products in a standardized way and to so quickly, easily and secure from Australian Red Cross Blood service (NBA 2011). Stock Movement dashboard in bloodNet allows transferring and discarding blood and blood products. BloodNet system also provides a predefined list of blood products that can be ordered by another health facility (NBA 2011). Australian Nation Blood Authority (NBA) enabled interfacing between laboratory Information System (LIS) and BloodNet system to abolish double-entry and to speed up the transfer of data and information between all stakeholders in the blood sector.

American Association of blood banks (AABB) – NBE Exchange web based system

AABB is the global leader in standard development accreditation and

implementation of quality system in transfusion of medicine and cellular therapies. AABB has a program known as National Blood Exchange (NBE) that is mandated to provide important services to blood banking. NBE coordinates the distribution of more than 185,000 units of blood components in United States of America. (American Association of Blood Banks, 2018)

NBE Exchange web based system provides blood centers with the opportunity to have easily and efficient move surplus blood to areas that need the blood and provide health facilities with additional blood if the need is high compared to the current amount of blood available in hospital.

Blood Bank in India

The management information system (MIS) of blood bank in India allows health facility to request the blood when need arises from the blood bank. The blood bank keeps the following details; patient name, type of the blood group which requested, hospital name and its address, the name and the details of the doctor who request for blood and time and date the blood is needed. The blood bank system also provide the several criteria when searching for blood, these include city wise criteria and group wise criteria. (Makau 2014)

A Review of the related Frameworks

A framework of the blood transfusion chain in Netherlands

Van Hoeven LR et al (2016) proposed a framework that provides an overview of steps of the transfusion chain from the donor to the recipient in different hospitals. It identifies and highlights areas within the transfusion chain with a room for improvement. This framework presents four main applications

that are linked to the steps of the chain and identify the data that is necessary for each application. The applications used in this framework include.

- i. Risk factors
- ii. Predict future blood products needed
- iii. Benchmark blood use
- iv. Improve process efficiency

ICT Service Oriented Architecture (SOA) framework that enable blood distribution to health facilities in South Africa rural areas.

Afried, C et al (2012) in his study proposed Information Communication Technology (ICT) service oriented architecture framework to assist effective blood inventory management in rural hospitals in South Africa. The architecture encourages the integration of local hospitals services and availing the services to the web through a provincial e-health service hub. The framework includes the blood services of the health facilities and changes them from paper phase to the electronic phase through the service hub.

A Generic modeling framework to evaluate network blood management in Canadian blood service

Blake et al (2014) proposed a generic modelling framework to evaluate network blood management. Data from this generic modeling framework was derived from transaction level record extracted from Canadian blood service production database. This framework is useful in regional blood supply chain and blood distribution site in

Canada. Data for the modeling framework was derived from transaction level records extracted from Canadian blood service production database. Information regarding all blood units produced, distributed or disposed at any distribution site in Canada between certain periods of time is obtained

A DSS (Decision Support System) Architecture to manage platelet production supply chain for regional blood centers

T.K sen (2010) proposed a DSS architecture that is optimized for delivery of platelets from production centers to transfusion centers (Health facilities). A decision support system is an information system that supports business or organizational decision-making activities. The DSS architecture assists the regional blood center manger to schedule the shuttle transportation and supply of whole blood from collection sites to the regional processing center.

Framework Adopted

The researcher adopted the ICT Service Oriented Architecture (SOA) framework that enables blood distribution to health facilities in South Africa rural areas

Reasons for adopting this framework

-It incorporates blood services in hospitals and transforms them from physical and paper phase to electronic / ICT phase

-It emphasizes the integration services within health facilities and avails these services to the web through E- health service hub.

-E- Health service hub in this framework is implemented using SOA architecture using web service interface which bring about

interoperability between health system and services connected.

-E-health service Hub provides set of integration blood services which gives connectivity amongst all health facilities and healthcare service.

Methodology

The nature of the this research was to identify current methods used when sharing blood products among health facilities and blood banks and identify they challenges faced when using this methods. In addition users were involved in designing and testing a web-based prototype to enhance sharing of these blood products between health facilities. Thus descriptive research method was applied employing a mix of both quantitative and qualitative approach.

A total of 24 health facilities/participants from Nairobi County purposely selected and 2 participants from one blood bank participated this research study. These health facilities were selected based on their geographical areas which span across the entire county. Purposive sampling technique was used: This method is important when the researcher needs to study a certain cultural domain with knowledgeable experts within. Questionnaires ad interviews were used to gather data from the selected participants. After the data collection, all the questionnaires were adequately checked for data verification. The data was be tabulated in the line with the objectives of the study. The tabulated data was subjected to both quantitative and qualitative analysis.

Quantitative data was be analyzed through descriptive statistics in the form of frequencies tallies and percentages. The statistics were generated using statistical package for social sciences (SPSS) and data

obtained was presented through pie charts tables. Qualitative data was analyzed by organizing them in accordance with research questions and objectives

The responses received were positive in determining if coming up with the proposed intervention was a viable idea. The preferred methodology for the development of the prototype is Rapid Application Development (RAD).Also SOA was used in the system where REST web service server was applied requesting HTTP requests and getting the response to the user. The researcher did an evaluation on prototype functionality and usability to get the user perceptions of the prototype and how it can be improved to enhance process of blood sharing.

Scope of the study

The participants were doctors and lab technicians from health facilities in Nairobi County .The participants were to be selected based on their professional which is relevant to the study .In each health facility selected the researcher targeted one participants (24 health facilities *1=24). Also from Kenya National Transfusion Center the researcher targeted two participants. This gives a sample size of 26 participants. However the response rate was 85% which represents 22 participants out of targeted 26 participants. The participants were from ten level 3 health facilities, nine levels 4 health facility, two level 5 health facilities and one level 6 health

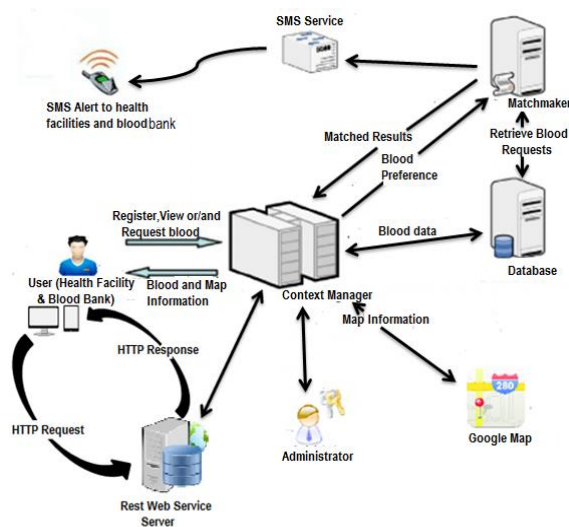
System description

System design

The proposed solution is a web based application that achieves proper cooperation between the blood banks, health facilities having them interacting with a single central database. The Proposed system is a responsive website hosted and on an apache web server. The system is deployed on a

central server while being accessing and collecting data from browsers on different devices in distributed areas. The system was designed to be used by different blood banks and hospitals. All functionality of the system will be accessible over the internet through a web browser.

When blood is donated in any health facility, the facility captures data about the blood products including the amounts and the date of blood donation. This is accessible to all health facilities and blood banks that want to request for these blood products in case of any emergency or shortage.



A conceptual representation of the perceived system architecture

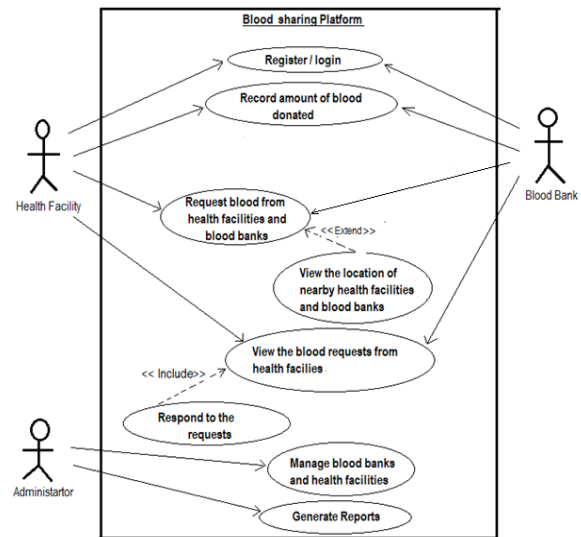
The intervention includes Google maps to assist the health facility that require blood products to locate nearby blood bank or health facility that has the blood products needed. The SMS Alerts will be important when health facility request blood products. This will ensure the blood requests a received and being responded in timely manner thus

convenient during emergencies situations in health facilities

System users

The system have three users namely; Health facility, Blood bank and the system administrator. The user Case below shows how system users interact with the system.

Use Case diagram



Implementation

Based on the intervention functional and non-functional requirements, technology design decision were made and the ICT intervention was implemented using the following technologies

-**HTML5 and CSS** for designing the web interface of the web application - these tools were used to code the system user interface (UI).

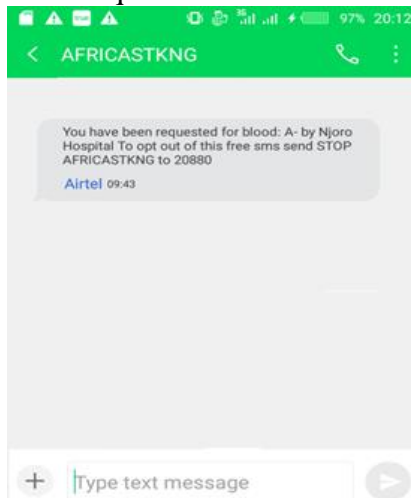
-**Laravel 5.3 a PHP framework and bootstrap 3** for developing server-side scripting codes front end- Laravel was used to strengthen security and speed up database migration without data loss. Tables were created to store, display, manipulate and delete database records. Forms were also

created to allow for user input and retrieval of data from the database.

-**Microsoft SQL (Structured Query Language) Server** for database design – MySQL was used because it guarantees data security and integrity. MySQL database use primary keys hence avoiding avoids redundancies. The foreign keys in MySQL database aids in creating relationships between entities.

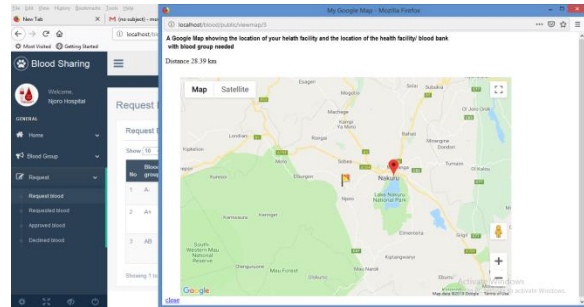
-**Apache web server** for hosting the application – Apache web server will make the system readily available to any health facility or blood bank. Also modification can be made to suit system users’ needs

-**Africa’s Talking API Messaging** – This was used to send effective alerts text messages and feedback SMS text messages when blood requisitions are made



A sample of a notification text message

Google maps API – This is to allow health facilities to locate the nearby health facilities or blood banks with the blood needed



A sample of a map showing the distance and location of the health facility with blood needed

Results

a) Sources of blood during emergencies when blood stocks are inadequate

During emergencies most health facilities (63.6%) request blood from other health facilities, followed by donation from patient’s family member with a percentage of 27.3% and then 9.1% source the blood from donation campaign

	Frequency	Percent
Donation from patient's family member	6	27.3
Request blood from other health facilities	14	63.6
donation campaign	2	9.1
Total	22	100.0

b) Current process and methods used when sharing of blood products between blood banks and health facilities.

63.6 % of the health facilities reported they use telephone calls when requesting blood from other health facilities. 36.4 % reported to use blood requisition forms. The research study found that lab technicians or doctors in these health facilities are the one make calls and fill forms when requesting blood from various health facilities.

	Frequency	Percent
Telephone calls	14	63.6
Fill requisition forms	8	36.4
Text messages	0	0
Email	0	0
Total	22	100.0

c) Challenges faced when using current process and in requesting blood.

9 out of 22 respondents (40.9%) reported that when using current processes in requesting blood the main challenge they face is the delay in blood supply. 8 out of 22 respondents (36.4%) reported the main challenge is that it takes time to get the response/feedback, 7 out of 22 respondents (31.8%) reported the challenges faced are hard to know the nearby health facility with required blood and Inconvenience when keeping blood requisition record. Only 1 out of 22 respondents reported that the current process is costly.

	Responses		Percent of Cases
	N	Percent	
It takes time to get response/ feedback	8	25.0%	36.4%
Hard to know nearby health facility with required blood	7	21.9%	31.8%
It is costly	1	3.1%	4.5%
Delay in blood supply	9	28.1%	40.9%
Inconvenience when keeping records	7	21.9%	31.8%
Total	32	100.0%	145.5%

System evaluation

Evaluation was done to ensure that the system requirements were met. Five health facilities were used to evaluate the proposed ICT intervention: three level 3 health facilities and two level 4 health facilities

Functionality Evaluation

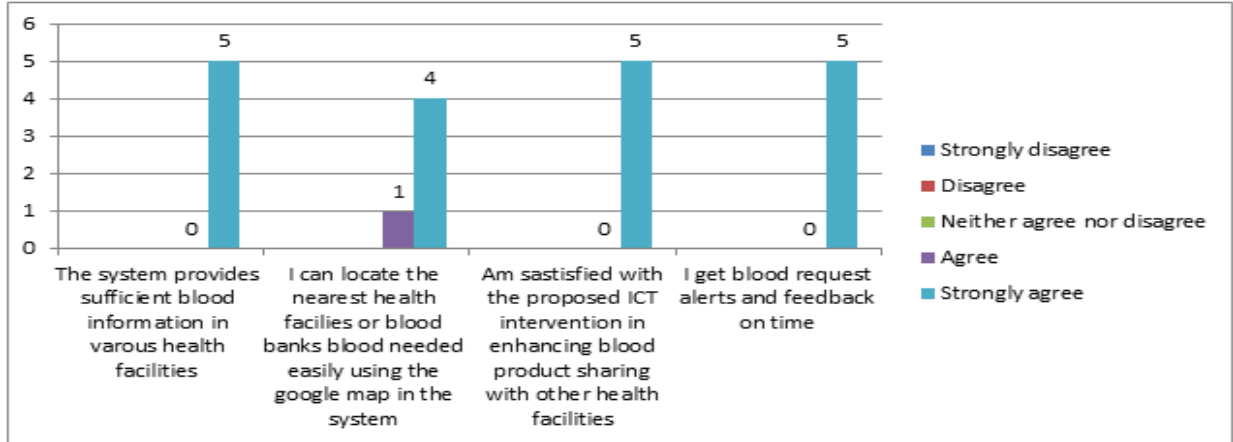
This was to access whether or not intervention/ system developed works the way it was intended.

All the five health facilities strongly agree that the system provides sufficient blood

Discussion

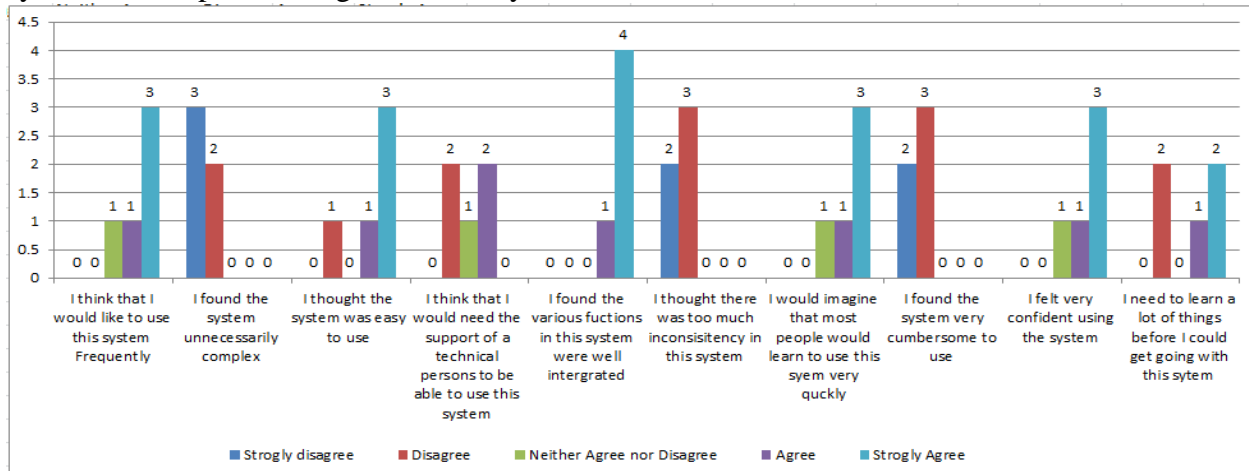
Most health facilities indicated that blood demand exceeds supply and this shows that blood is highly needed in every health facility. Having over 90% of the respondents with facilities to store donated blood also shows that this vital product is on a high demand. The results shows that most health facilities, during emergencies, they request blood from other health facilities or blood banks. However it was noticed that there is a problem of delay in blood supply during sharing since the mechanism used by many health facilities is telephone calls where doctors or lab technicians make calls to the health facilities asking them if there is available blood in their blood banks. After the blood is shared health facilities keep the record in files and this also was indicated as one of the challenges when using the current processes and mechanism

information from health facilities and blood banks; they get blood request alerts and feedback on time and them a satisfied with the system in enhancing blood products sharing with other health facilities. Four health facilities strongly agree that the system is easy to use while the other health facility only agrees. This was same to the functionality of locating nearest health facility or blood bank with the required blood easily through the Google maps in the system.



The respondents also filled in a System Usability Scale (SUS) which returned a score of 77.5 out of 100. This shows that the system was satisfactory, usable and acceptable. The System Usability Scale is a reliable tool for measuring usability of a system. 4/5 respondents agreed that they

would like to use this system frequently. 4/5 Greed that they found the system easy to use. On whether the system was easily learnable, majority of the respondents 3/5 respondents agreed that was easy to learn about the system.



Conclusion

Blood demand remains to be high and exceeds blood supply since blood is highly needed in every health facility. However it can be concluded that during emergencies health facilities source the blood by requesting it from other health facilities and blood banks. As far as the blood sharing among health facilities is concerned, delay in blood supply and not getting the feedback on

time during requisitions are the main challenges since the mechanisms used during blood requisitions are telephone calls and blood requisition forms. This proposed solution can be mitigate this scenario and assure of optimal sharing of blood and blood products

Limitation of the study

Difficulty in getting the respondents was the main challenge of this study since many health facilities did not want to disclose their blood information. In other health facilities those people who are responsible in

requesting the blood are lab technicians while in others, doctors are responsible to request the blood hence difficulty to get real respondents in different facilities.

Recommendations for future work

Respondents involved in the testing of the system suggested that they would like to get alerts and feedbacks of blood requests through phone calls. The use of phone calls alerts will ensure the blood requests will be notified on time thus more convenient during emergencies. Also respondents suggested that GIS should be incorporated in the system to locate areas where many people with a particular blood group are located. Drone technology can be incorporated to the system to transport requested blood to health facilities.

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The Impact of Robotic Activities on Secondary School Students' Interest in Physics in Kenya

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Abstract: Educational robotic activities can be used to support teaching of science subjects. Many secondary school students have little interest in Physics as a subject and hence only a few students select it in preparation of career progression. Robotic activities can be employed to facilitate practical learning in science subjects in general with the Physics subject benefiting the most. In Kenya, there is little research on the role robotic activities can play on learning of these subjects. This study developed robotic activities from educational robots fabricated by the researcher. The activities presented learners in secondary school with diverse opportunities of enriching their learning of Physics as a Science subject. The robotic activities were integrated into Physics topics to give the teaching and learning of this subject a new approach. The integrated robot activities were then introduced to Form 2 students in workshops carried out during weekends which included 3-day activities for the students. In this study 200, form 2 students were selected randomly from 20 schools in Kangema sub-county, Murang'a county in Kenya. The students were issued with questionnaires before and after exposure to the activities through the workshops for purposes of data collection. The quantitative data obtained was analyzed using descriptive statistics and inferential statistics. The findings of the study revealed that the robotic activities had a significant impact on students' interest in Physics. The study recommends that the government should facilitate the integration of educational robotic activities in the current secondary school Science curriculum in order to improve interest towards these subjects.

Keywords: Robotic activities, Science subjects, Educational robots, Integration, Exposure.

1. INTRODUCTION

According to Kopcha et. al, [1] robots have been beneficial in education and has yielded fruits in that it has led to motivating learners of all education levels to Science subjects. From their study they found out that use of robots through problem solving can support Science, Technology and Mathematics (STEM) in general. Jung and Won [2] indicated that activities around robots can be used to aid in education. According to them, some examples of robots that can support education include LEGO Mindstorms and other robot designs meant to aid the teaching process. They also noted that robot activities have been developed for learners in all education levels. The robot activities range from designing, programming and use of robots in education.

Science, Technology, Engineering and Mathematics careers are vital in providing manpower to a growing economy thereby enhancing innovation and greater productivity [3]. Students should go through the preparation process towards the STEM careers which calls for new perspectives to be adopted by schools to enhance the learning experiences, work integrity and interest in related career [4]. Research in STEM fields has grown immensely, with the priority of many researchers being contribution to the growth of the field, improvement in the STEM workforce and to maintain more students the fields in post-secondary institutions. Furthermore, the students are trained the STEM field in a way that they can compete in the global market [5]. According to Sadler *et al.* [6] students are prepared for the STEM related career long before they join post-secondary levels of education. This

agrees with the findings of Malin, Bragg and Hackmann [7], who indicated that secondary school education prepares the learners for the future career. The preparation process is complex, in that technology advances rapidly and therefore there is need to ensure tomorrow's job opportunities and the corresponding work force look different from today's [8].

According to Mwangi et. al [9] robots employed in education have a great impact on the process of teaching and learning of STEM subjects. They further indicated that the use of robot activities in learning of STEM subjects could motivate them to pursue STEM related careers. The use of these activities had greater impact in the primary school levels as compared to other educational levels. They further noted that they could still be beneficial in higher educational levels with some improvements. The study showed that the use of robots has a promising future for use in educational purposes. In this study the effect of integration of robotic activities to science subjects in secondary school is investigated

2. LITERATURE REVIEW

Scaradozzi *et al* [10] suggested an innovative approach of teaching using robotics. The approach suggested was tested using learners in a select Italian primary school. The study involved robots that ran on LEGO WeDo and LEGO MINDSTORMS NXT hardware and software. The robots were integrated in teaching Science and Mathematics topics. The study found that robotics should be integrated in teaching Science and Mathematics in line with the school curriculum

so as to witness an upgrade in learning of the subjects. While integrating the robotic activities in Science and Mathematics, the aim should be to expose learners to hands-on opportunities that engage them in applying the knowledge and skills they have learned across disciplines.

Mwangi et.al [11] developed robot activities and investigated how they could aid learners understanding abstract concepts in STEM and concluded they were indeed very effective. They noted that use activities developed around robots made learning fun, and interesting. It was noted that teaching and learning of STEM was more effective with improved participation of learners.

Robotics activities are helpful in that they make learning of STEM subjects fun and engages the learners in hands-on learning environment [12]. Khanlari [13] conducted a qualitative study with experienced robotics teachers where he wanted to establish whether robotics could have effect in teaching STEM subjects. The study concluded that robotics and related activities help learners understand STEM subjects and enhances learners' interest in STEM fields. Nugent et al. [14] conducted research where they collected data from 2409 campers, competition, and club participants during six years. The study revealed that robotics activities increased participants' awareness of STEM content perceived and problem-solving skills.

In Canada, Khanlari and Mansourkiaie [15] evaluated the perceptions of teachers on using educational robots in STEM education. One research questions involved teachers providing sample topics in Primary School Science subjects that would be easily taught using robotics. This was after the participants were exposed to functional robots that used hardware and software of LEGO MINDSTORM. From the findings, it was evident that the teachers indicated that robots can be used in teaching some Mathematics topics such as geometry, multiplication, addition, subtraction, division, measurement, shapes, orientation and movement of bodies. Teachers also stated that science topics such as circuits, force, motion, force, matter and structures. The exposure of the learners to the robots and related activities was very helpful in learning of Mathematics and other sciences. The learners were able to understand the link between scientific and mathematical theory with real life problems.

From the review of literature on the effects of educational robotic activities, it is evident that use of educational robots in STEM is beneficial in learning process. The learners are exposed to problems in STEM that are real-life [16]. This makes them feel like scientists in the course of learning which in turn affects their career choices in the future [17]. Further, educational robotics provides enormous benefits to students at different levels. Some of the benefits include; development of critical thinking skills, STEM process skills, acquiring skills problem solving, growing in creativity, persistence, social interactions, and skills in teamwork [18], [19].

The literature reviewed reveal a lot of benefits of the use of robotic activities in STEM education. This study investigated the effect of robotic activities to secondary school students' interest in STEM subjects where the activities are integrated to Physics and Mathematics.

3. METHODOLOGY

In this study, students and Physics teachers were exposed to a 3-week workshop which was conducted at Murang'a university of technology where learners interacted with educational robotic activities. The activities were integrated in Physics topics with the aim of investigating their impact in learning of the subjects.

This study adopted constructivism in developing educational robots, a form of manipulating artifact [20], which was key for the learners in knowledge construction. Through the robots, teachers offered learners with opportunities to engage on explorations that are hands-on and provided tools for learners to construct knowledge in a learning environment. Through the theory, robotics activities were integrated in teaching Physics thus providing the learners to cultivate skills in Physics.

3.1 PARTICIPANTS

The study was conducted among 200 Form 2 students selected randomly from 20 schools in Kangema Sub-County: 3 girls' schools, 4 boys' schools and 13 mixed secondary schools. This implied that, 30 girls were selected from girls' only secondary schools, 40 boys from boys' only secondary school and 130 from mixed secondary schools as shown in Figure 1.

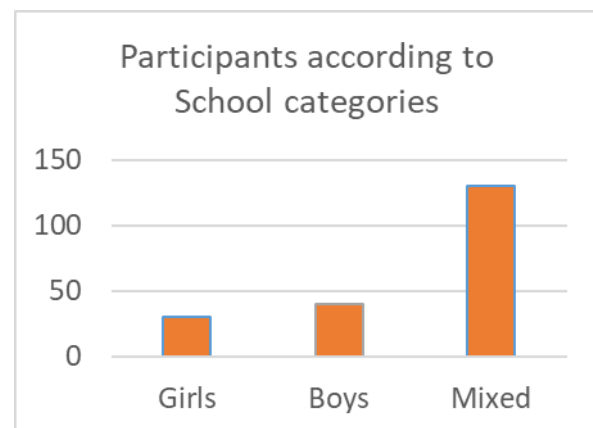


Figure 1 Participants by School Categories

In terms of gender, 90 girls and 110 boys participated in the study as shown in Figure 2.

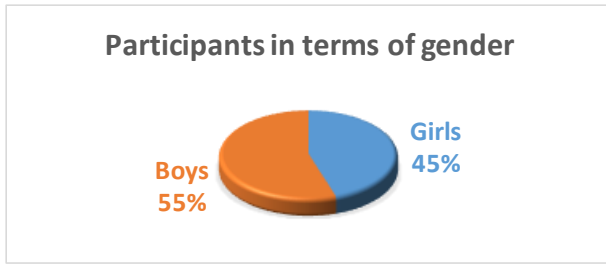


Figure 2: participants by gender

3.2 IMPACT OF THE ROBOTIC ACTIVITIES

Robotic activities were developed based majorly on the two main robot designs which included car and arm. The robots fabricated by the researcher were used for the development of the activities after which the selection of the most suitable and relevant activities were selected for a workshop. A workshop was then organized where Form 2 students and Physics teachers were taken through the activities. The robot designs fabricated are shown in figure 3 and 4 respectively.

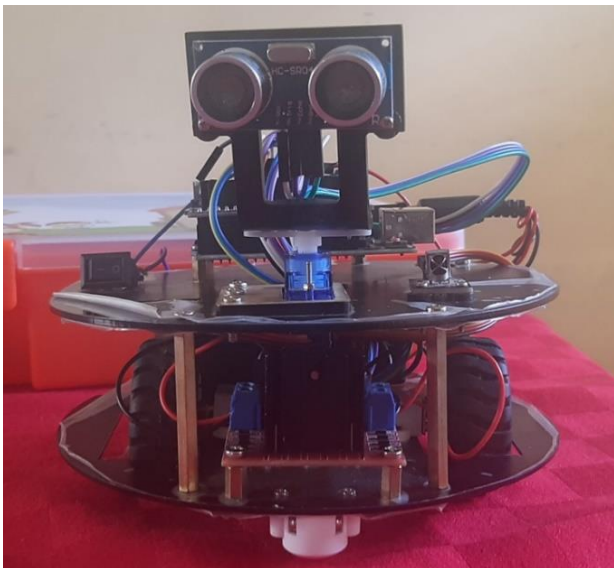


Figure 3: Robotic Car



Figure 4: The Fabricated Robotic Arm

Some of the activities employed in the workshop are shown in Table 1

Table 1: Robotic Activities integrated in Physics

Robotic activities	Topics Integrated
Basic electronics activities	Measurements of values of components, basic electricity
Robot part identification and assembly	Sensors and transducers, work and energy
Line following robot activities.	Reflection of light, Linear motion, Speed, Acceleration
Obstacle avoidance robot activities.	Waves, Reflection and distance Calculation
Robotic arm rotational dynamics activities.	Geometry, Angles, Circular motion Rotation, Translation, Forces and Energy

The robotic activities were spread over three workshop days. In the first session the learners were taken through activities revolving around basic programming, robotic car and arm. The learners moved the car forward and backwards in linear motion at constant speed, acceleration or deceleration. The students learnt to programme various robot parts like the motor and sensors. The learners would move the robot car forward and backward in linear motion using the Arduino Uno programming environment.

In the 2nd session, the main focus was physics where the students were reminded on the basics of motion at constant speed and were asked to programme their robot to move

forward and then backward at constant speed. They were instructed to assemble an ultrasonic sensor on their robot in order to detect the distance from a stable object. They also assembled and programmed infra-red sensors on the robotic car in order to detect a black path drawn on some wooden boards. In this session, the students were exposed to the concept of acceleration, deceleration, circumference and perimeter of particular shape.

In the 3rd session Physics activities related to the robot arm were also introduced. The activities included the process of assembling the robotic arm and the physics concepts connected to the arm assembly. The activities included; Forces, Circular motion, Rotation, Translation, calculation of speed and estimation of distance.

In order to establish the impact of the robotic activities to learners' interest in Physics, the learners filled a questionnaire with items assessing the impact of the activities in understanding, perception and interest. The questionnaires were administered before and after exposure to the robotic activities. Data obtained from both teachers and students was then analyzed.

4. RESULTS AND DISCUSSION

In order to assess the impact of the robotic activities on students' interest towards Physics, the researcher formed the basis of seeking opinion from students. The students were presented with questionnaire items that assessed the impact of the robotic activities. The items included were understanding of Physics and Mathematics, made learning of Physics and mathematics fun, enhanced creativity, interest in classroom participation and how the robotic activities made topics in Physics and Mathematics easier. The students were presented with these items prior and after exposure to the educational robot. The pretest responses findings are reported herein.

On a Likert scale of Strongly Disagree to Strongly Agree, the participants were presented with several statements regarding robotic activities and integration in Physics and Mathematics. The findings are as presented in Table 2.

From the findings, 40.6% (78) indicated that exposure to robotic car and robotic arm can give them a better understanding of Physics topics they learn in class to a moderate extent; 26.0% (50) to a great extent, 13.5% (26) to a lower extent, 12.0% (23) to no extent and 7.8% (15) to a very great extent. From the findings, 38.0% (73), 34.9% (67), 9.9% (19), 8.9% (17) and 8.3% (16) of the respondents were of the opinion that exposure to robotic car and robotic arm can raise interest of the students in participating in the classroom activities to a moderate extent, to a great extent, to a lower extent, to no extent and to a very great extent respectively. The findings also demonstrate that 57.8% (111) of the respondents indicate that exposure through robotic activities can change their interest in Physics to a moderate extent; 15.6% (30) indicated to a great extent, another 15.6% (30) indicated to a lower extent, 8.9% (17) to no extent and 2.1% (4) to a very

great extent. According to 38.5% (74) and 21.4% (41) of the learners who agreed and strongly agreed, the use of robotic activities in learning of Physics improved their attitudes towards the subject; 21.4% (41) neither agreed nor disagreed, 11.4% (22) disagreed and 7.3% (14) strongly disagreed. From the responses, 27.6% (53) and 28.1% (54) of the learners agreed and strongly agreed respectively that the use of robotic activities should be introduced in the curriculum to improve students' attitudes in Physics.

Table 2: Pretest Findings on Impact of Integration of Activities

	To no extent	To a lower extent	To a moderate extent	To a great extent	To a very great extent
In your own opinion, would you say the exposure to robotic car and robotic arm can give you a better understanding of the Physics topics you learn in class	23 (12.0%)	26 (13.5%)	78 (40.6%)	50 (26.0%)	15 (7.8%)
In your own opinion, would you say the exposure to robotic activities can raise interest of the students in participating in the classroom activities	17 (8.9%)	19 (9.9%)	73 (38.0%)	67 (34.9%)	16 (8.3%)
In your own opinion, to what extent do you think the exposure through robotic activities can change interest in Physics?	17 (8.9%)	30 (15.6%)	111 (57.8%)	30 (15.6%)	4 (2.1%)
The use of the robotic activities in learning of Physics and Mathematics can change my attitude towards Physics.	14 (7.3%)	22 (11.4%)	41 (21.4%)	74 (38.5%)	41 (21.4%)
The use of the robotic activities if introduced in the curriculum can improve students interest in Physics	21 (10.9%)	23 (12.0%)	41 (21.4%)	53 (27.6%)	54 (28.1%)

After being exposed to the educational activities, and working with the robots on their own, the students were presented with the same questionnaire items. The Likert scale responses on robotic activities and integration are as presented in Table 3.

The posttest findings on the impact of robotic activities are as presented in Table 3.

Table 3: Posttest Findings on Impact of integration of Robotic Activities

	To no extent	To a lower extent	To a moderate extent	To a great extent	To a very great extent
Did the exposure to the robotic car and robotic arm give you a better understanding of Physics topics you learn in class	6 (3.1%)	5 (2.6%)	21 (10.9%)	58 (30.2%)	102 (53.1%)
In your own opinion, would you say the exposure to robotic activities raised interest of the students in participating in the classroom activities	5 (2.6%)	4 (2.1%)	17 (8.9%)	48 (25.0%)	118 (61.5%)
In your own opinion, to what extent has the exposure through robotic activities changed your interest in Physics as a subject	3 (1.6%)	7 (3.6%)	17 (8.9%)	47 (24.5%)	118 (61.5%)
The use of robotic activities in learning of Physics and Mathematics improved my attitude towards Physics	2 (1.0%)	3 (1.6%)	8 (4.2%)	79 (41.1%)	100 (52.1%)
The use of robotic activities should be introduced in the curriculum to changed students attitudes towards Physics	2 (1.0%)	5 (2.6%)	1 (0.5%)	62 (32.3%)	122 (63.5%)

The post exposure opinion on whether exposure to the robotic car and robotic arm gave the respondents a better understanding of the Physics topics learnt in class had 53.1% (102) of the respondents indicate to a very great extent, 30.2% (58) to a great extent, 10.9% (21) to a moderate extent, 3.1% (6) to no extent and 2.6% (5) to a lower extent. It is also clear that 61.5% (118), 25.0% (48), 8.9% (17), 2.6% (5) and 2.1% (4) of the participants indicated that exposure to the robotic car and robotic arm raised interest of the students in participating in the classroom activities to a very great extent, to a great extent, to a moderate extent, to no extent and to a lower extent respectively. The opinion of 61.5% (118), 24.5% (47), 8.9% (17), 3.6% (7) and 1.6% (3) of the respondents was that exposure through robotic activities changed their interest in Physics to a very great extent, to a great extent, to a moderate extent, to a lower extent and to no extent respectively.

Majority of the respondents, a total of 93.2% (179) were of the opinion that the use of robotic activities in learning of Physics changed their attitude towards the subjects to a great extent and to a very great extent; 4.2% (8), 1.6% (3) and 1.0% (2) indicated that use of robotic activities improved their attitude towards Physics to a moderate extent, to a lower extent and to no extent respectively. According to 95.8%

(184) of the respondents, the use of robotic activities should be introduced in the curriculum to improve students' attitude in Physics to a great extent and to a very great extent.

General observation of the pretest and posttest results reveal differences in responses on questionnaire items regarding the use of robotic activities. Through a paired sample t-test, the difference in the responses was assessed. Paired samples t-test involves a comparison of the means between two groups that are related on the same dependent variable that is continuous. It can be used to test differences in the means of paired measurements such as those taken at two times that are different, for instance a pre-test and a post-test score where an intervention has been administered between the two points in time.

In this study, a paired samples t-test was applied for the categorical sub-variables with the same scale of measurement and measured one major aspect of the study; as a result, the sub-variables would be aggregated into one variable using a measure of central tendency.

From the descriptive statistics, it is evident that there are differences in opinions of the respondents on the five items between the pretest and posttest responses. Prior to running the paired sample t-test, the pretest responses were aggregated into one variable, the pre-impact, while the post responses were aggregated into one variable, the post impact through the use of the mean. The paired sample t-test was then conducted. From the summary presented in Table 4, it is evident that the overall pretest impact had a mean of 3.0486 (approximately to a moderate extent) while the posttest impact had a mean of 4.3628 (approximately to a great extent).

Table 4: Pre-Impact and Post-Test Impact Means

	Mean	N	Std. Deviation	Std. Error Mean	
Pair 1	Pre-impact	3.0486	192	.75732	.05466
	Post-impact	4.3628	192	.69130	.04989

The difference between the overall impact in the pretest responses and posttest responses is significant. The fact that that the posttest overall mean is higher than the pretest overall mean is a clear indication that the educational robotic activities had an impact in their understanding of Physics topics you learn in class, raised interest of the students in participating in the classroom activities, changed their interest in Physics as a subject and also improved their attitude towards Physics as shown in Table 5.

Table 5: Paired Sample t-test on Impact

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Pre-impact – post-impact	-1.31424	.77945	.05625	-1.42519	-1.20328	-23.363	191	.000

In this study, robotic activities were integrated in various Physics topics. The activities equally elicited a lot of interest in learning of the selected topics and promoted the learners’ participation in the learning process. The learners would also handle the activities individually and as a team. The integration of such activities in to the secondary school syllabus would improve learners’ interest and most importantly attitude of the Science subjects and thereby improving performance and learners’ perception towards these subjects.

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

From the research finding it can be concluded that:

- i. The exposure to the robotic activities gave the learners a better understanding of Physics topics they learn in class thereby making the subject fun.
- ii. The exposure to robotic activities raised interest of the students in classroom participation hence making the learning environment very interactive and making the learners more creative in the learning of physics which agrees with the findings of Afari, E., & Khine, M. S [21].
- iii. The exposure through robotic activities changed learners interest in Physics as a subject and learners expressed their interest in choosing Physics in preparation of future STEM career. This agrees with finding of Ben-Bassat & Ben-Ari [22].
- iv. The use of robotic activities in learning of Physics improved learners’ attitude towards Physics
- v. The use of robotic activities should be introduced in the curriculum to improve students’ attitudes towards Physics

5.2 RECOMMENDATIONS

Robotic activities should be integrated in Physics to promote teaching and learning of the topics. This will require the government of any given country to facilitate the integration of the activities in the current curriculum. Through policy makers in education, the curriculum should be reviewed so as to adopt educational robotic activities to be utilized in the teaching and learning process.

6.0 ACKNOWLEDGEMENTS

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Smart Worker Monitoring System Using Facial Recognition and Deep Learning Techniques

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Abstract: Organizations are increasingly tracking staff gadgets and monitoring their output. We want to create a system that not only protects employees' privacy but also aids companies in managing their workforce and obtaining accurate productivity data. We were able to keep an eye on the background activity and record the names of the applications and their active times. A facial recognition system is used to implement the employee authentication procedure, maintaining authenticity.

Keywords: privacy; active; recognition; authentication; authenticity;

1 INTRODUCTION

The Covid-19 pandemic has significantly changed the way we work, go to college, participate in other activities, and live our lives. By 2025, remote employment was supposed to be the new standard, however due to the epidemic that is still going on, most businesses have already gone remote. While some organizations found it difficult to keep up in the beginning, the majority have subsequently adjusted. Companies have begun considering how to apply this working method in the long run. Business executives are beginning to understand that remote work is a permanent solution that will help businesses survive the pandemic. Home-based employment is here to stay. Future work will be carried out in this manner. The future of work will be conducted in this manner, and it will soon become the norm. More than half of all international businesses provide their employees the choice to work remotely. Only 16 percent of these companies have only remote employees; the other organizations have both on-site and remote employees. The ability to work from home promotes location freedom, a better work-life balance, and less stressful commutes.

1.1 OBJECTIVE

Even though most businesses now permit employees to work from home, they still have trouble managing projects, tracking tasks, and employee productivity. To accomplish these goals, other software must be used and controlled, which increases the workload. Employers urgently need to find ways to cut this overhead while still getting the most out of employee time and effort. It needs a comprehensive solution that not only helps the organizations but also considers the needs and privacy of the employees while preventing an imbalance. This system ought to be able to offer productivity analyses based on the needs of the organization. The management would benefit from the reports of this analysis in the overall review of the activity. The management would be assisted by the results of this If none, delete this of this analysis in conducting an overall evaluation of the employees work.

2 LITERATURE SURVEY

The details regarding the Literature survey conducted on the topic of 'Smart Worker Monitoring System Using Facial Recognition and Deep Learning Techniques' are provided in the Section. The papers referred to for the survey and their content are listed below

2.1 A Robust Psychologically-Oriented Emotion Recognition Method Using Transfer Learning

In this study, they use an image with the face region and an image with the eyes region as our training input data. We resize the image into 13251325 for the face region and 450900 for the eyes region because the image may not be the same size. The size in question corresponds to the average of the cropped data for the specified kinds. Cropping the face and eye regions are the two duties in the pre-processing phase. Cropping the face area out of the images is the first duty. The photographs from the datasets are not cohesive, and many of them have extraneous elements like white backgrounds and haircuts. This extraneous information could introduce noise into the training process because the entire image would be taught. To extract the area around the face, they use Haar Cascade. The Haar Cascade characteristics in our experiment produce fairly accurate results for the marking of the facial region. This preprocessed dataset will be applied to the training of the model on the entire face. Eyes Cropping is the second , In their initial they try at the eyes cropping method, they use Haar Cascade features to separate the eyes region from the cropped face region. However, this approach might not produce the results they were hoping for. Based on the results of their experiment, they define pleasing cropping as the crop that encompasses the eye region while leaving out the majority of other portions. the lower portion displays the outcome of the suggested strategy, whereas the upper part displays some unsatisfactory cropping using solely Haar Cascade characteristics. They can observe that the suggested strategy produces a more satisfying outcome in an area that

covers the eyes region but does not include a large amount of additional region.

2.2 Facial Emotion Recognition using Convolutional Neural Networks

In this proposed paper, the authors trained the model using the Cohn Kanade and Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS) datasets to complete the facial emotion recognition challenge. Black and white images from a neutral state to an emotion were captured sequentially at Cohn Kanade. The six emotions in the dataset are anger, happiness, sorrow, fear, disgust, and surprise. Facial landmark points are provided for each image. Due to the lack of neutral images in the dataset, we split each image sequence into two parts, with the first half being labelled as neutral and the second part matching to the face expression. 3000 photos were the product of manual tagging. With the aim of extracting images from the RAVDESS collection, frames were obtained every 0.5 seconds. They received 11000 photos as a consequence. Since raw data contains a lot of noise and unused information, feeding it to the model is not recommended because this could lead to poor learning performance. Selecting the appropriate data preprocessing methods is just as crucial as choosing the appropriate model to develop. Since the majority of their data consisted of grayscale photos, which have one channel instead of three channels like rgb images do, they first transformed every image to grayscale in order to better extract features from the data. Second, they identified faces in photos and cut them out in order to reduce the noise. They did this to get rid of extra background information. Finally, they zoomed in on the image to make the pivot points in the faces more obvious. They performed the data preprocessing stage using the OpenCV framework. Choosing the appropriate machine learning algorithm was the last stage. Even subtle distinctions in appearance matter and can affect the outcome in their problem domain. For this challenge, they chose to employ convolutional neural networks. A particular kind of artificial neural network called a CNN is one of the most effective and popular techniques for solving computer vision issues. The CNN is made up of a series of convolutional layers, each of whose outputs is only connected to small areas of the input. To do this, a filter is slid across the input, and at each point the dot product between the two is computed (creating a convolution between the input and filter). With the help of this structure, the model can learn filters that can identify particular patterns in the input data.

2.3 A Facial Expression Recognition Method Using Deep Convolutional Neural Networks Based on Edge Computing

The weaknesses of conventional data augmentation techniques are examined and compiled in this work. The

paper enhances Cycle GAN, suggests a technique of facial expression identification based on constraint cycle consistent generation to resist network, and introduces class constraint condition and gradient penalty rule to address the issue of class imbalance in the existing face expression database. The experimental findings demonstrate that the enhanced generation model can learn the fine texture information of the face image more effectively, and the generated image has a high level of quality. The enhanced face expression picture recognition benefits from a stronger classification and recognition effect from the improved discriminator network. This paper studies facial expression recognition and expression image data enhancement. Although some achievements have been made, there are still some deficiencies, which need further research and improvement. First of all, the expression recognition and data enhancement in this paper are based on the static image, while the emotional changes in real life are of a certain timing, and the static image can only reflect the expression state of a person at a certain time. The next work will focus on the data enhancement of video sequence. Secondly, in the process of data enhancement, neutral expression image is used as the source domain and other expression images as the target domain, but the expression state of human in the real scene can be transformed at will. How to enhance the data without limiting the expression state of the input image is also a direction that can be improved in the future.

2.4 Facial Expression Recognition via Deep Learning

Their goal in this project is to use a new CNN architecture to improve the accuracy of facial emotion classification. We integrate multiple databases to get the final one because deep networks require a large database for training. After setting up the database, they fixed the CNN architecture's batch size input to 165, and they trained the architecture using fine-tuning from the Visual Geometry Group (VGG) model to produce the first model. They repeat training their CNN architecture in a second stage to increase classification, but this time the fine-tuning is accomplished using the initial model they have already obtained. Finally, they have their final model. The suggested network has four convolutional layers; the first three are followed by max pooling, and the last layer, which has 748 connections, is followed by a fully connected layer. It analyses facial photos and categories them into one of the six facial expressions: surprised, furious, disgusted, joyful, neutral, or happy. The MUG, RAFD, and Ck+ databases are used to analyze the proposed design. Results and identification rates show that our approach outperforms cutting-edge approaches. In order to train the model for this project, authors used pictures of faces that were in fixed positions. Authors want to expand our model to include other facial positions in future projects. This will enable us to examine the effectiveness of trained facial emotion detection models like VGGNet

2.5 Facial Emotion Detection Using Deep Learning

In order to evaluate the two models (Model-A and ModelB) on their capacity to detect emotions, they create a network based on the ideas from and. This section provides a description of the data used for training and testing, an explanation of the specific data sets used, and an assessment of the outcomes from the usage of two distinct datasets and two models. They have proposed a deep learning-based method in this research. method for reading facial expressions from a picture. they converse utilizing their proposed approach employing the JAFFE and FER-2013. The proposed solution's performance assessment The application of a face emotion detection model is done in terms of accuracy of validation, computational difficulty, detection rate, learning rate, validation loss, and step-by-step calculation time, a trained and test sample were used to examine their suggested model. photos, then assess how well they performed in comparison to earlier current model. The experiment's findings demonstrate that the model In terms of the outcomes of emotion detection, suggested is superior. compared to earlier models mentioned in the literature. The research demonstrate that the suggested model is generating cutting-edge repercussions on the two datasets.

2.6 Discussions of Different Deep Transfer Learning Models for Emotion Recognitions

This study gave clear and in-depth comparisons of the models and looked at the transfer learning of five CNN models. This work can be used by researchers to find suitable models and transfer learning techniques in situations where there are software or hardware restrictions. Authors looked at various CNN models, which have different frameworks. They are

typical transfer learning models used in a variety of disciplines: All of the frameworks for ResNet-50, Exception, EfficientNet-B0, Inception, and Dense Net differ from one another. Using various data preprocessing approaches, training methodologies, and models, we carried out extensive trials on datasets of varied sizes. Following a comparison of different data preprocessing methods and consideration of the significant sample size differences among all FER2013 emotion classes as well as the generalizability of both large and small datasets, they chose to employ class weight training. The accuracy of all models improved when they underwent freeze + fine-tuning, whether with the large dataset Affect Net or the small dataset FER2013 (with the exception of EfficientNet-B0, whose accuracy remained constant, and DenSeNet121, which became less accurate than the other models). This was the case when ImageNet was used as the source domain. Additionally, it was found that using Affect Net as the source domain instead of ImageNet resulted in less influence from transfer learning techniques and no appreciable differences in training results in a multi-source transfer learning experiment using FER2013 on source domains related to the target domain. This result revealed that selecting the appropriate source domain can improve transfer learning models more significantly than selecting the appropriate training approach. However, producing the best training results in transfer learning requires using several source domains and training methods, depending on the model.

3 CONCLUSION

As job monitoring and tracking become an important component of remote working conditions, this software attempts to help enterprises achieve their goal of higher productivity. Observations showed that the software was able to successfully track the majority of background applications and URLs accessed. In addition to tracking them, it also kept track of their names and how long background apps were running.

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