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Design of Quantum Learning-Based Numeracy Worksheet on Uncertainty and Data Content

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ABSTRACT

Previous study attempted to create worksheets to boost students' comprehension and numeracy skills. However, there is little research on designing numeracy worksheets using Quantum Learning. This study intends to provide uncertainty-and-data-content-of-numeracy worksheets using Quantum Learning to help students enhance their grasp of probability material and numeracy skills. The incorporation of Numeracy into the uncertainty and data content worksheet distinguishes this study from past research. This is supported by earlier research, which suggests that incorporating Numeracy in worksheets can help pupils improve their numeracy skills. Furthermore, Numeracy, which is concerned with problem solving in a variety of real-world scenarios, adheres to Quantum Learning, whose learning stages connect the content to real life. This study employs the 4D development paradigm, which has been condensed into 3D: define, design, and develop. Data gathering methods include questionnaires, observation of learning implementation, and testing. The analysis is both descriptively qualitative and descriptively quantitative. This study involved 31 kids from one of Indonesia's junior high schools. The findings of this study show that the worksheet is valid, practical, and successful, indicating that it was doable. The study found that students' grasp of probability material improved, as did their numeracy skills. The worksheet creation will assist instructors to construct excellent mathematics learning combined with numeracy.

Keywords: Worksheet, Numeracy, Quantum Learning, Probability

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INTRODUCTION

Numeracy literacy is important in facing global challenges in the 21st century. Numeracy literacy skills can help people to achieve their goals (Deda et al., 2023). According to the Australian Curriculum, Assessment and Reporting Authority (2014), numeracy is the knowledge skills of students in using mathematics in various situations. This knowledge and skill mean the students are active problem solvers. Numeracy is an appropriate concept used to identify the knowledge and skills needed to accommodate the demands of mathematics in personal and public life. numeracy also has an important role in social life, including participation and contribution to society (Geiger et al., 2015). Thus, Numeracy is the need for individual readiness to face challenges or situations that, over time, continue to change. Numeracy can help people understand mathematics in real life to make judgments and decisions that follow reason and logic (Kemdikbud, 2021).

The numeracy skills of students in one of the cities in Indonesia do not match the importance of Numeracy. Based on the Education Report Card results in one of the junior high schools in Indonesia, only 44.44% of students reached the minimum competency for Numeracy. In addition, in the Class Minimum Competency Assessment, the percentage of students answering correctly on numeracy competencies was only 27.3%.

Quantum learning

Choosing the right learning model can be an effort to face the challenges of the 21st century, one of which is the Quantum Learning model (Trinova et al., 2022). According to DePorter & Hernacki (2015), Quantum Learning is a learning model that sharpens students' understanding and memory and provides an understanding that learning is a fun and rewarding process. The implementation of Quantum Learning familiarizes students to actively construct understanding and knowledge concepts through a learning process that familiarizes students with observing, aligning concepts with real events related to real life, and completing tasks both in groups and independently so that students are not passive observers (Shoimin, 2014).

Quantum learning is considered effective in helping students solve problems associated with everyday life (Trinova et al., 2022). In addition, to improve students ability to solve problems to help achieve their skills, the use of real-life problems as something that is learned can be done (Kusuma et al., 2018). Supported by the opinion of Husna et al. (2022), teachers in the classroom can implement Numeracy by paying attention to the content of lessons that must be adapted to real-life problems to find solutions.

There are six stages of Quantum Learning: Enroll, Experience, Label, Demonstrate, Review, and celebrate (DePorter et al., 2013), see Figure 1:

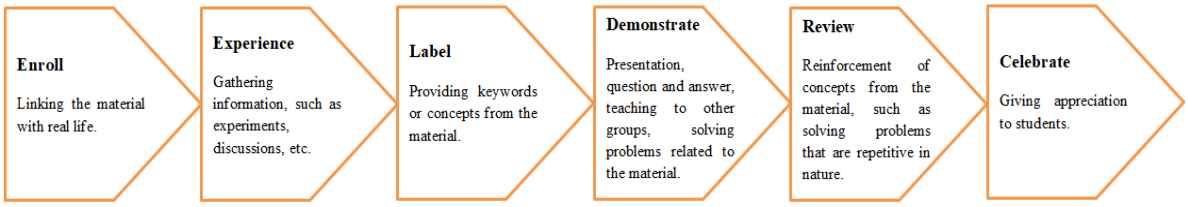


Figure 1. Stages of Quantum Learning

Worksheet

According to Ozmen & Yildirim (2015), a worksheet contains materials to increase students' activeness so they can know the meaning of the learning process. Students will be actively involved in completing worksheets, such as finding the concept of learning material, exploring knowledge, linking the knowledge learned with previous experience, conducting experiments, and others. In line with this opinion, the worksheet is a sheet that assists students in completing learning tasks accompanied by material, summaries, and steps for implementing learning tasks that refer to the Basic Competencies that

students must achieve (Prastowo, 2018). Thus, a worksheet is not only a sheet containing tasks that students must do, but students will be involved in finding concepts from the material discussed.

Worksheet is the same as the Student Activity Sheet. However, since the implementation of the 2013 curriculum, the term teaching materials in the form of activities has become worksheets (Sari & Lepiyanto, 2016). A worksheet was designed in this research because it makes it easier for teachers to carry out learning and can help students understand learning materials (Fitriani et al., 2017). In addition, based on research conducted by Miftah & Setyaningsih (2022), worksheets integrated with Numeracy can also improve students' numeracy skills, making it feasible to use in the learning process. This is by the problems researchers encountered in one of the junior high schools, that the worksheet used was purchased from the printing press. Students find it difficult to understand the material being studied because there are no structured learning steps to build an understanding of the concept of the material being studied.

Uncertainty and data content of Numeracy based on quantum learning

Based on the results of the Class Minimum Competency Assessment, it is known that the percentage of students answering correctly on probability material is lower than that of students answering correctly on other materials, which is only 1.65%. These results show that the numeracy skills of students are quite low, and there is a low understanding of students in probability material, so efforts are needed to improve the numeracy skills and understanding of students related to probability material. This can be done through the learning model used in the learning process. The use of learning models can help students in understanding the material. Quantum Learning is one of the learning models that can improve students' understanding and memory (Zahran, 2019). Sudarman & Vahlia (2016) also stated that Quantum Learning can contribute to developing the ability to understand mathematical concepts.

The application of Quantum Learning will familiarize students with observing and align concepts with real events related to everyday life. Quantum Learning will familiarize students to be active in constructing understanding and concepts of knowledge learned to solve problems in groups and independently (Shoimin, 2014). This is per Numeracy, which relates to problem-solving in various real-life contexts. Since its inception, numeracy has been related to the mastery of concepts and mathematical thinking skills, so it is not limited to covering only the application of skills in number operations. Also, the numeracy process of formulating, applying, interpreting, and evaluating can mean that students are active as problem solvers (OECD, 2017).

Significance of the research

Few research examines efforts to design Quantum Learning worksheets, such as the result research by Ikhsan & Sugianto (2021), which states that works based on Quantum Learning integrated with the Quissis application are feasible and can improve students' understanding. In line with that, the

research results of Toharun (2022), show that the worksheet based on Quantum Learning developed is feasible and can improve students' learning outcomes through students' activeness in constructing their understanding. Research by Miftah & Setyaningsih (2022), that integrating Numeracy in worksheet can improve students' numeracy skills. Numeracy integration in the mathematics learning process in the classroom can provide benefits for students in the future, including learning achievement and readiness to face the challenges of the 21st century (Husna, Isnarto, & Ali Shodiqin, 2022). In line with the opinion of Septian et al. (2023), students can face the challenges of the 21st century by integrating Numeracy into mathematics learning.

There is a void of research that examines how worksheet based on Quantum Learning integrate with Numeracy, especially related to the importance of Numeracy in facing global challenges in the 21st century which is currently not matched by good numeracy skills by students. This research is important to provide alternatives for improving numeracy skills and understanding of mathematics material by students. It will benefit mathematics education researchers, teachers, students, and stakeholders.

Research objective

Based on this description, researchers see the need to develop a numeracy-integrated worksheet based on Quantum Learning to improve students' numeracy skills and understanding of material. Until now, there has been no research on this matter. The formulation of the problem statement of this research is how the process and results of the design uncertainty and data content of numeracy worksheet based on Quantum Learning.

METHOD

This research is a development research or Research and Development (R&D) using the 4D development model by Thiagarajan. According to Maydiantoro (2021) , the 4D development model has four stages: Define, Design, Development, and Disseminate. However, in this research, only up to the Development stage is sufficient to produce uncertainty and data content of numeracy worksheet based on Quantum Learning. This was done due to time and cost constraints (Pradhana & Sutopo, 2022). This is in line with the opinion of Trinova et al. (2022), to consider aspects of time cost so that the 4D development stage only reaches the Develop stage, which is the production of products after limited trials. The 4D development model is more concise but includes complete development procedures. In addition, the 4D development model was chosen because it is often used in research and development of teaching materials and following the needs of researchers to produce valid, practical, and effective worksheets (Mulyatiningsih, 2016). The development flow in this research is as follows:

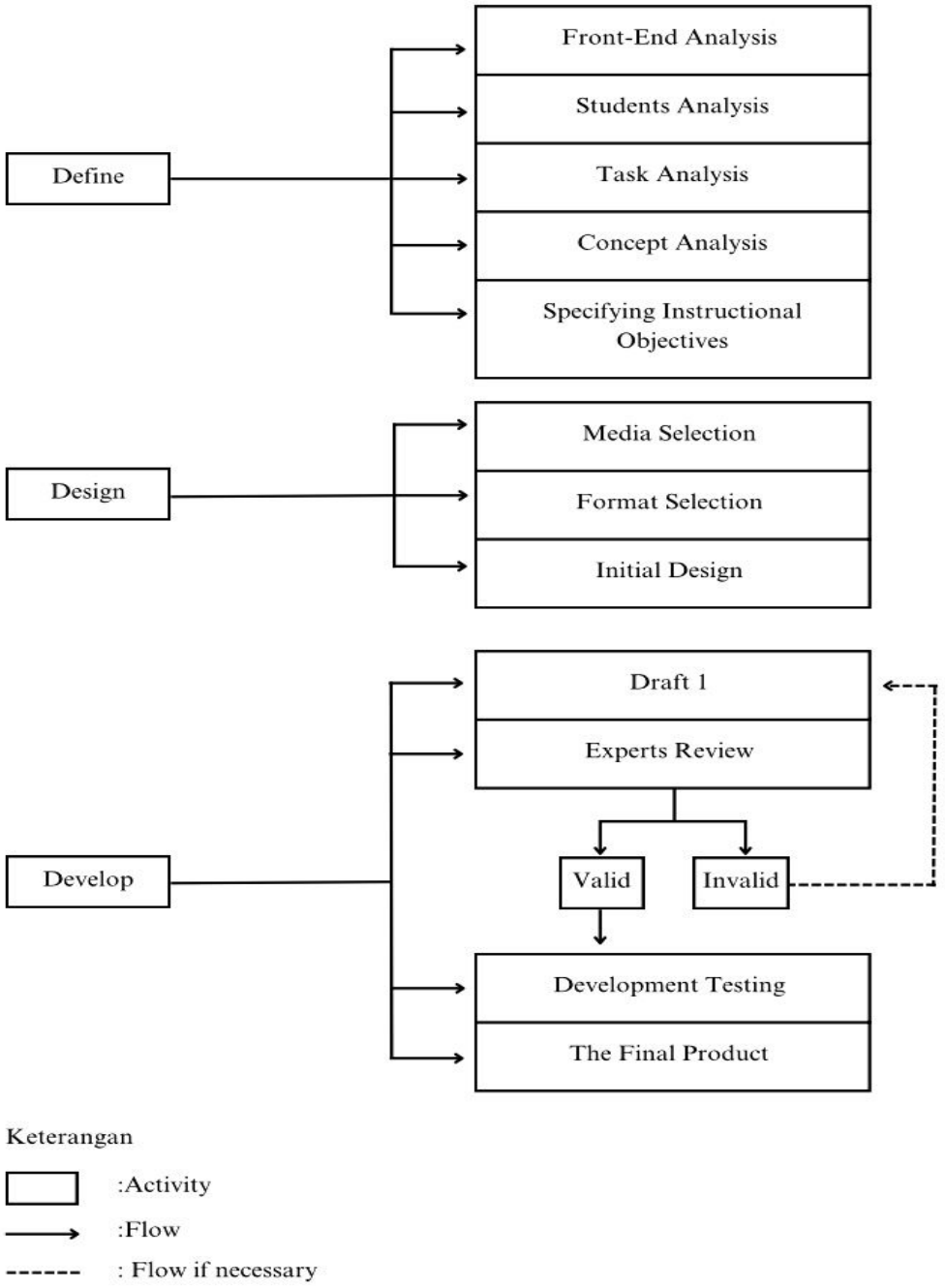


Figure 2. The Development Flow

Design stage

The Define stage in this research includes front-end analysis, which is analyzing the basic problems that occur in the learning process, analyzing the characteristics of students who are the subject in this research, task analysis is analyzing and mapping the subject matter that has not been understood by students so that the percentage of numeracy skills is low, concept analysis is analyzing the concept

of material to be used in worksheet which is done by analyzing learning outcomes, determining the learning objectives to be achieved in worksheet which are adjusted to task analysis and concept analysis.

Design stage

The analysis conducted at the Define stage is the basis for the Design stage. The Design stage in this research includes media selection, namely determining the media that is by the material to be developed, format selection, namely determining the strategy, approach, or learning method used, learning resources, and worksheet presentation, initial design, namely determining the elements of the worksheet structure to be designing and compiling research instruments. The instrument used in this research is an expert validation sheet which is used to measure the validity of the worksheet as well as the validity of the response questionnaire instrument and learning outcomes test, learning implementation sheet and student response questionnaire sheet to determine students' responses to worksheet, learning outcomes test sheet to determine the effectiveness of worksheet.

Develop stage

The Develop stage in this research includes Draft 1, a worksheet compiled according to the initial design. Followed by expert assessment related to the validation of worksheet and research instruments by four validators. The worksheet's validation sheet and the response questionnaire instrument were filled in by experts using a Likert scale with a score of 1-4. While the numeracy question validation sheet and the validation of the learning outcomes test instrument were filled by experts using a Guttman scale with two answer options, yes or no. The worksheet validation sheet was prepared based on the adaptation of the worksheet eligibility criteria according to (Widyantini, 2013). The validation sheet of numeracy integration in the worksheet and learning outcomes test instrument is based on indicators according by (Pusmenjar, 2020). Response questionnaire items are prepared based on adaptations of the criteria by (Arsyad, 2019). The results of these instruments become quantitative data in this research. They will be analyzed descriptively quantitatively by calculating the percentage and then adjusted to the criteria for validity and practicality (Riduwan, 2018). If components in the worksheet are declared invalid, revisions will be made according to the validator's assessment. Qualitative data is obtained from notes or suggestions given by experts and students on the validity test sheet and student response questionnaire. The data will be analyzed using descriptive qualitative to improve the worksheet.

After expert assessment, the development trial was continued by using the worksheet in learning with 31 students from class VIII-B consisting of 11 male students and 20 female students as research subjects whose in the Class Minimum Competency Assessment showed that they had a relatively low percentage of numeracy skills, especially on data content and uncertainty. In addition, the mathematics learning process at the school has not been integrated with Numeracy and has not maximized the involvement of students in constructing their knowledge. Furthermore, conducting learning outcome

tests and filling out student response questionnaires. The results of the learning implementation sheet and the student response questionnaire were calculated as a percentage and then adjusted to the practicality criteria (Riduwan, 2018). The student learning outcomes test calculated the score and percentage of completeness, then adjusted to the effectiveness criteria.

RESULTS & DISCUSSION

Result

Define Stage

Front-end analysis

The process of designing a worksheet in this research begins with the final initial analysis stage, namely, analyzing the basic problems that occur in the learning process. Based on information from teachers and deputy head of the curriculum at one of the junior high schools in Indonesia, the mathematics learning process is still centered on the teacher and students are not accustomed to constructing knowledge from the material studied. The worksheet used is purchased from the printing press. Students find it difficult to understand the material being studied because there are no structured learning steps to build students' understanding.

Students analysis

Based on the analysis of students, according to information from the teacher, students in class VIII-B in one of the junior high schools in Indonesia have not learned the material of probability. In addition, there is no habituation of numeracy in learning. The results of the Education Report Card at the school show that only 44.44% of students can achieve the minimum competency for Numeracy, and only 27.3% of students can answer correctly on numeracy competencies in the Class Minimum Competency Assessment. Only 1.65% of students answered correctly on probability material. The low percentage of numeracy skills and understanding of the probability material is in class VIII-B, which will be used as the research sample.

Task analysis

In this research, the material used is probability and is divided into three sub-materials on the worksheet: sample space and sample points, theoretical probability, and relative frequency.

Concept analysis

The concepts in this worksheet are the learning achievement of phase D mathematics of the independent curriculum on uncertainty and data content, namely students can explain and use the notion of chance and relative frequency to determine the expected frequency of one event in a simple experiment (all experimental results can appear evenly).

Specifying instructional objectives

Learning objectives are formulated according to the previous task and concept analyses. The learning objectives that will be used in the worksheet are linking sample space and sample points with real life, constructing the concept of sample space and sample points by conducting experiments, solving problems related to sample space and sample points, linking probability with real life, building the concept of the probability, solving problems related to the probability, linking the relative frequency with real life, building the concept of the relative frequency by conducting experiments, solving problems related to the relative frequency.

Design Stage

Media selection

The Design stage starts with media selection. The media used to develop probability material integrated with Numeracy and based on Quantum Learning is a worksheet which is prepared using Canva.

Format selection

The learning model used is the Quantum Learning model, which consists of 6 stages: Enroll, Experience, Label, Demonstrate, Review, Celebrate. The learning resources used are the Gakko Tosho Team's Grade VIII Junior High School Mathematics Student Book in 2021, the Ministry of Education and Research's Grade VIII Mathematics Student Book in 2022, the Open Junior High School Learning Module on Probability Material in 2021. The worksheet is made with A4 paper size.

Initial Design

The initial design was prepared by determining the elements of the worksheet structure, namely the title, learning instructions, learning outcomes, concept maps, tasks and work steps, and assessment.

Develop Stage

Draft 1

The Develop stage begins with draft 1. Draft 1 was prepared according to the initial design of worksheet elements at the Design stage: title, learning instructions, learning outcomes, supporting information, tasks and work steps, and assessment. Draft 1 of the worksheet is:

Title

The title includes making: (a) The front cover contains the title of the material, grade, user identity, and author. (b) Worksheet identity contains the identity of the author, supervisor, size of the worksheet, number of pages, media used in the preparation, and author's institution. (c) The back cover contains the logo and address of the institution.

Figure 3. Cover and Identity of Worksheet

Learning instructions

Learning instructions include making (a) Learning instructions for the use of worksheets to make it easy and provide directions for students when using worksheets in the learning process (b) Learning outcomes and flow of learning objectives. (c) Concept maps of probability material to be studied.

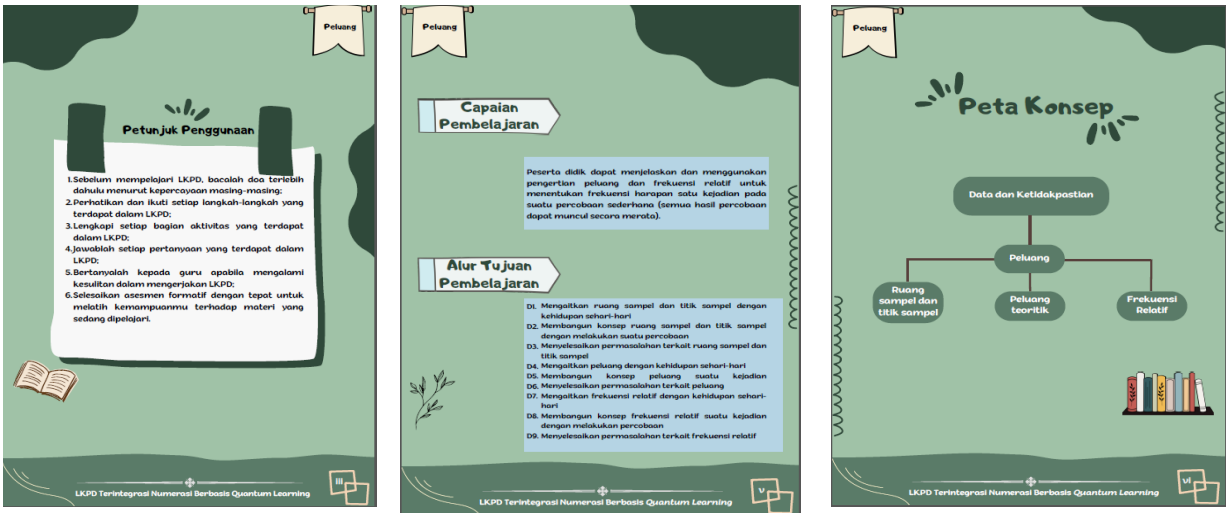
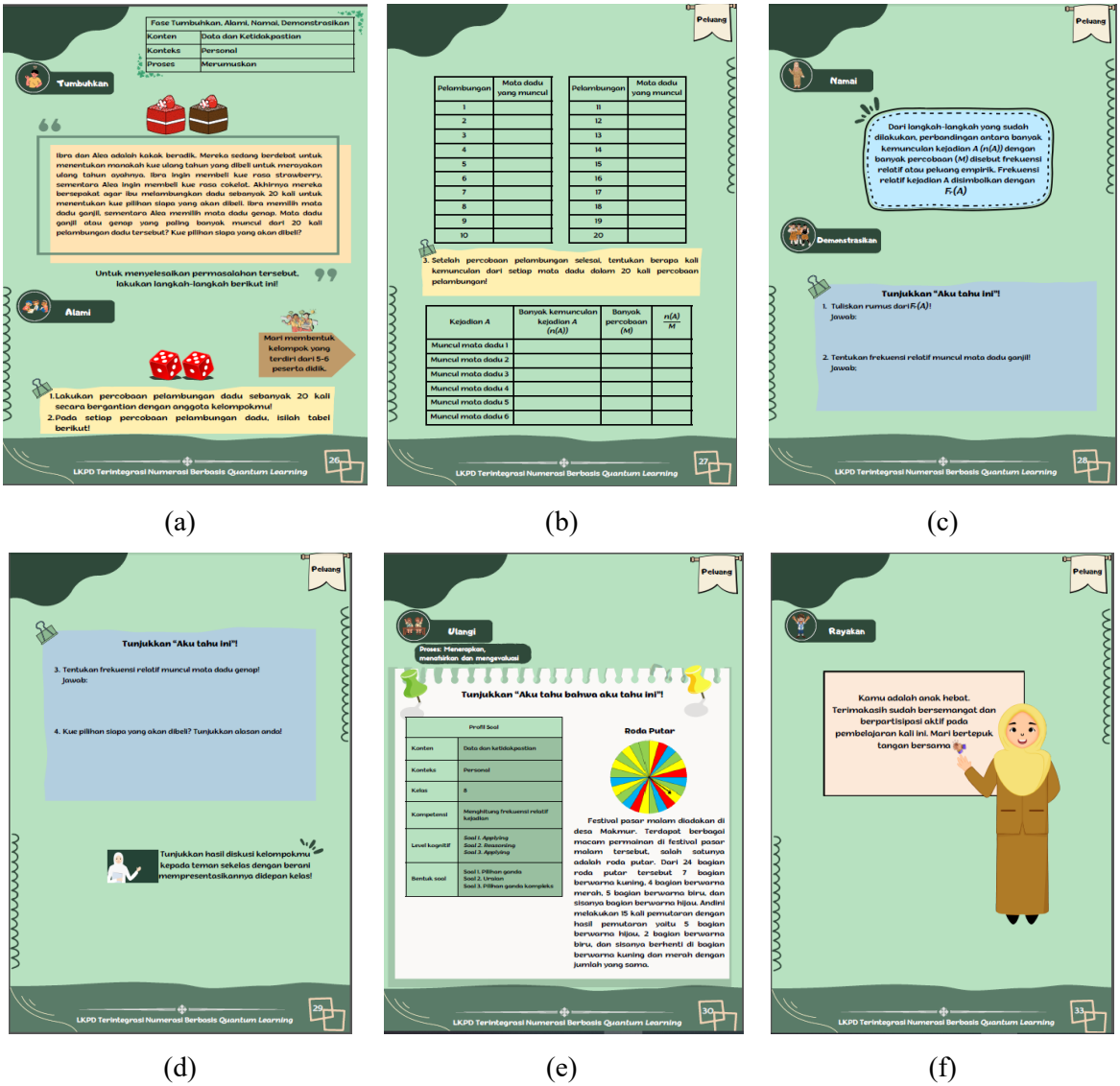


Figure 4. Learning Instructions, Learning Outcomes, Concept Maps

Tasks and Work Steps

Making tasks and work steps, namely compiling the learning stages that students must carry out in each sub-material on worksheet, which is adjusted to the stages of the Quantum Learning. (a) Enroll, namely students connect the material to real life. (b) Experience, namely students gather information, such as experiments and discussion. (c) Label, namely teacher provides keywords or concepts from the

material. (d) Demonstrate, namely students making a presentation, question and answer, teaching to other group, and solving problems. (e) Review, namely reinforcement of concepts from the material, such as solving repetitive problems. (f) Celebrate, teacher, giving appreciation to students.



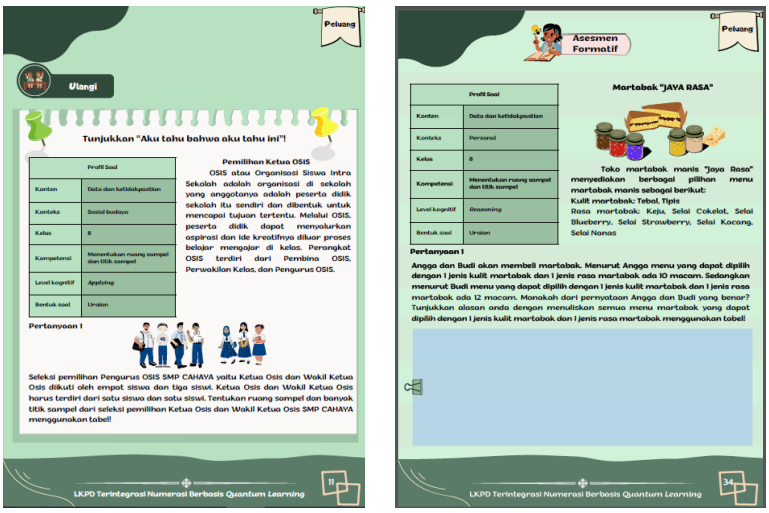
(a) (b) (c)

(d) (e) (f)

Figure 5. Tasks And Work Steps

Assessment

Assessments include compiling numeracy questions to : (a) Numeracy question in the review stage, which must be done at the end of each sub-material. (b) Numeracy questions in formative assessments must be done after all material has been learned.



(a) (b)

Figure 6. Assessment

Expert review

After Draft 1 is compiled, the next step is expert review. The review is carried out by providing a validation sheet to be filled in by the validator. Validators can also provide comments and suggestions for improving the developed worksheet. In addition to worksheet, research instruments, namely student response questionnaires and learning outcomes tests were also validated. The results of worksheet validation is:

Table 1. The Validation Score of Worksheet

Assessment Aspect	Assessment Indicator	Total Score	Maximum Score	Percentage (%)	Validity Criteria
Worksheet in General	The material on the worksheet is by the curriculum	23	24	95,8333333	Very Valid
	Using standard language	13	16	81,25	Very Valid
	Worksheet appearance	21	24	87,5	Very Valid
	Based on Quantum Learning	51	56	91,0714286	Very Valid
	Total	108	120	355,654762	
Validity Percentage (%)				**90**	**Very Valid**

Based on the results of the worksheet validation score, the percentage of validity obtained is 90% with the validity criteria which is very valid. Worksheet is valid if the experts state that the components on the worksheet are consistently interrelated (Akker, 2012).

Numeracy questions on worksheet and learning outcomes test instruments have also been validated to validators. The validation results stated that the questions on the worksheet and the learning outcomes test were declared valid, namely the content, context, competence, cognitive level presented

in the questions were by the question profile, and the questions presented were by the learning objectives. The numeracy questions in the worksheet were also declared valid after several revisions were made according to the validator's suggestions.

The results of the validation of the student response questionnaire instrument, obtained a validity percentage of 93.75% with the validity criteria which is very valid.

Development testing

After the expert assessment, the development trial was carried out by using the worksheet in the learning process for three meetings, namely the first meeting (November 17, 2023), the second meeting (November 20, 2023), and the third meeting (November 23, 2023). During the learning process, observers assessed the implementation of learning. After that, a learning outcome test was conducted, and 31 students of class VIII-B filled in a response questionnaire. The results of the practicality of the worksheet is:

1. Learning implementation sheets

The results of learning observations are as follows:

Table 2. The Results of Learning Observations

Number	Activity	Total Score	Max. Score	Percentage (%)	Category
1	Introduction activity	15	15	100	Very Good
2	Core activity	15	15	100	Very Good
3	Closing activity	15	15	100	Very Good
	Total	45	45	300	
	Practicality Percentage (%)			**100**	**Very Good**

Based on the results of learning implementation, learning activities take place by the design that has been made. Thus, the percentage of practicality of worksheet is 100% with a very good category and practical interpretation.

2. Students' response questionnaire

The results of students response questionnaire, the worksheet has a practicality percentage of 92.238% with a very good category and a very practical interpretation, meaning that students and teachers easily use worksheet in the learning process (Anggraini et al., 2016). According to students, they did not experience significant difficulties during the worksheet, the steps in worksheet were clear and easy to follow, the language used was also easy to understand. Lestari & Muchlis (2021) believe that worksheet is practical if the language and sentences on worksheet are easy to read and understand. The opinion of Putra & Syarifuddin (2019) also states, worksheet is said to be practical, one of which is the presence of clear learning instructions on worksheet. The results of worksheet effectiveness based on the learning outcomes is:

Table 3. The Score of Students Learning Outcomes Test

Class	Total Students	Completed		Not Completed	
		Total	Percentage	Total	Percentage
VIII-B	31	31	100	-	-

Based on the learning outcomes test, all students scored ≥75, so the percentage of student's completeness was 100%. worksheet is in the very good effectiveness category, with a very effective interpretation.

Discussion

The big idea of this research is to produce a feasible worksheet integrated with Numeracy based on Quantum Learning that can help improve numeracy skills and students' understanding of uncertainty and data content, especially probability material. The research findings show that worksheet can improve students' understanding of probability material and help improve students' numeracy skills. The effectiveness of worksheet is related to students' understanding of the material in the worksheet (Loka et al., 2022). The worksheet can improve students understanding of probability material through structured learning steps and involve student's activeness in the learning process. Following the research results of Rodiyana (2018), Quantum Learning is very good and efficient to provide concept understanding to students. In this research the Quantum Learning stage, namely Enroll, the teacher provides examples associated with real life, so that students can find out the relationship between probability material and real life or experiences encountered. Students often also provide other relevant examples. Students feel more interested and motivated to learn the material through this stage. Numeracy in learning can be done by providing contextual, interesting, and current stimulus that stimulates students curiosity (Khakima et al., 2021). In the Experience stage, students collect data about probability material by conducting experiments and discussions. Students find it easier to understand the material when they are directly involved in constructing their understanding, such as conducting experiments or discussions. Quantum Learning accustoms students to find the concept of the material being studied through experience or experimentation before they can finally conclude the concept. This is the best learning process for providing understanding to students (Zahran, 2019). After experimenting, students are given keywords from the material at the Label stage. At this stage, students can understand that their experiments, such as coin flipping, are related to probability material. At the Label stage, students can also know the right steps or formulas that must be used to solve problems related to probability material. Following the opinion of Anisa et al. (2019), based on students' experience, they can provide identity, sort and define the material at the Label stage.

Ikhsan & Sugianto (2021) stated that there were deficiencies in the implementation of Quantum Learning in their research, namely the worksheet facility, so students who are active in the learning

process are still lacking. In this research, students are involved in various activities, such as discussing, conducting experiments, presentations, and answering questions and answers, which can provide students with opportunities to be active. The activities in the worksheet are also presented coherently starting from the sample space and sample points, theoretical probability, and relative frequency. worksheet received positive responses because the material presented was coherent and emphasized understanding of concepts (Sevina et al., 2022). In line with this, through understanding the concept of material, students will be able to solve problems and apply them to real life with the knowledge they already have and more easily learn and understand more complex material (Ginting & Sutirna, 2021).

The worksheet can improve students' numeracy skills by presenting problems related to real life and numeracy problems with various contexts. The results of Anggraini & Setianingsih (2022), state that to improve numeracy skills, it can be done with direction from the teacher, reminding mathematical concepts, and increasing practice problems to train students numeracy skills in understanding, application, and reasoning. This is per the Quantum Learning stage, namely Repeat, the teacher reinforces concepts to minimize misconceptions among students, then students solve the problems presented in numeracy problems independently. The teacher's attitude by reinforcing the material is expected to increase students' interest, attention, and motivation (Zahran, 2019). The context presented in numeracy questions is related to real life, students state that numeracy questions related to real life make it easier for students to understand and determine problem-solving. Especially in the learning process, students are accustomed to linking material with real life, so they can use their understanding to solve problems. This is in line with the research results of Anggraini & Setianingsih (2022), which states that students find it easier to implement and explore concepts that have been understood to solve problems with the context of everyday life. worksheet helps students understand material concepts and improve numeracy skills, so worksheet has an important role (Miftah & Setyaningsih, 2022). The research results of Miralda & Marhaeni (2023), show that the use of worksheet is effective for improving students Numeracy.

Referring to previous research's success in using Quantum learning models and numeracy integration in learning, this research also shows that the numeracy worksheet based on Quantum Learning is declared feasible to use and can improve students' understanding and Numeracy. There are limitations in the research, namely the analysis of worksheet effectiveness data is only with descriptive statistics, so these results only apply to the class used as the research subject, not representative of the population, and cannot be generalized.

CONCLUSION

This research is design the numeracy worksheet of uncertainty and data content based on Quantum Learning uses the 4D development model which is simplified into 3D, Define, Design, and Develop with the Define stage, namely front-end analysis, to find out the basic problems in the learning

process, analysis of students who are the subject of research, task analysis to map the subject matter to be used, concept analysis by analyzing learning outcomes, and formulation of learning objectives tailored to task analysis and concept analysis. Followed by the Design stage, namely media selection, format selection, and making initial worksheet designs. The last stage is Develop, namely the preparation of worksheet as a whole or draft 1, expert assessment to determine the validity of worksheet, development trials using worksheet for three meetings, followed by filling out questionnaires and conducting learning outcomes tests. The worksheet was declared valid, practical, and effective. The research findings show an increase in students' understanding of chance material and an increase in numeracy skills with numeracy worksheet based on Quantum Learning that familiarizes students with connecting material with real life, constructing their understanding independently, and familiarizing students with solving numeracy questions. This research can be followed up and become an opportunity for future research to be able to test the effectiveness of the worksheet on other materials and a wider population, to produce research findings that are more accurate and can be generalized in general. This research can also continue until the disseminate stage.

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