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Assessment of High School Students' Ability to Solve Structured Problems with Ideal Model on Acid-Base

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Problem-solving is one of the abilities that a student must-have in the 21st century. This is because students' ability to solve problems is expected to increase their competence of higher-order thinking skills (HOTS). Problem-solving ability can be improved in several ways for example, the use of a certain instructional model, worksheets, and assessment or assessment based on problem-solving. This study aimed to develop and implement structured problem-solving assessment with the IDEAL model on acid-base materials, salt hydrolysis, buffer solutions, and acid-base titrations to examine students' problem-solving abilities. The instrument development model used adapts the ADDIE model with four steps, namely analysis, planning, development, and implementation. The research sample were 34 high school students in grade 11 in Sidoarjo, East Java. The result is that the problem-solving ability with the lowest percentage are in the acid-base titration material for the Act on strategy indicator at 27.21%, while the highest percentage of skills are found in the buffer solution material for the Explore solution indicator at 89.5%. This study implies that the test instrument for further research is to measure students' ability to solve structured problems with the IDEAL model on acid and base. This study implies that the test instrument for further research measures students' ability to solve structured problems with the IDEAL model on acid-base, salt hydrolysis, buffer solution, and acid titration. So that the problem solving process with the integration of problem solving problems can improve students' critical thinking.

Graphical abstract

Keywords

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1. Introduction

Problem-solving is an important component to improve students' cognitive abilities in solving and solving problems in the learning process. Problem-solving skill is related to thinking skill. Students who have good problem-solving skill

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will have good thinking skill [1, 2] . According to Wood et al (1976), the key to student involvement in problem-solving is the development of lesson plans that focus on current problems [3]. This is also in line with the research conducted by Jansson et al. (2015) which states that special teaching is needed to support problem-learning. Different learning designs are needed in order to solve problems of a given type of problem [4]. Every learning process has different type of problem. So each problem requires different learning method [5-9]. Interesting chemistry learning can be created if the teacher adapts each different theme using different methodologies [10]. Yaumi (2017) also stated that the 2013 curriculum is designed with characteristics that are expected to be able to developt between of spiritual and social attitudes, curiosity, creativity, cooperation with intellectual and psychomotor abilities in students [11]. This statement relates to the students' ability to solve problem because students with problem solving skill have a high curiosity, creative and critical thinking skill.

The Indonesian 2013 curriculum is more directed to equip students with a number of competencies needed in facing the 21st century. Some of the important competencies needed in the 21st century as formulated in the 4Cs are: (1) critical thinking with the aim that students can solve contextual problems using critical and rational logics; (2) creativity encourages students to be creative in finding various solutions, designing new strategies, or finding ways that were not commonly used before; (3) collaboration facilitates students to have the ability to work in teams, tolerance, understanding differences, able to live together to achieve a goal; and (4) communication facilitates students to be able to communicate widely, the ability to capture ideas/information, the ability to interpret information, and the ability to argue in a broad sense [12, 13]. Therefore, students' ability to solve problems is expected to increase students' competence in emphasizing higher order thinking skills (HOTS) which are part of 21st century skills.

Problem-solving is one of the theoretical bases that makes the problem the main issue in learning [13-15]. Dananjaya (2013) describes problem-solving as an effort to improve results through a scientific process to analyze, and understand success [16]. Therefore, to solve a problem one must get used to thinking independently. Meanwhile, Gulo (2002) states that problem-solving is a method that teaches problem-solving by placing an emphasis on solving a problem logically [17].

Learning is a combination of knowledge transfer carried out by a teacher and learning activities carried out by his/her students [18]. In learning activities, there is a communication relationship between students and students, interactions between teachers and students, as well as interactions between students and learning resources [19-21]. The current problem-solving instrument test is usually applied by teachers in the form of student worksheets as well as ill-structured problem-solving in learning that needs to be further developed so the stages of problem-solving abilities are more focused and structured to improve students' higher-order thinking skills.

According to Hamiyah & Jauhar (2014) problem solving can stimulate the development of students' thinking progress to solve the problems they face appropriately and stimulates the development of students' thinking skills creatively and thoroughly by carrying out a coherent process in highlighting problems from various aspects. However, problem-solving has weaknesses in determining the level of problem difficulty according to the students' knowledge and experience, a relatively longer time allocation, and student learning habits that are not in accordance with the problem-solving learning process so it makes students feel bored and eliminates their enthusiasm for learning [2].

Based on the problems of problem-solving abilities and various existing weaknesses, it is necessary to develop an instrument for measuring and assessing students' problem-solving abilities. Students' problem-solving ability in problem-solving types can train students' higher-order thinking skills (HOTS), critical thinking skills and ability to analyze and solve complex problems. In general, students have fairly good problem-solving skills, it just needs to be trained so that students' ways of reasoning and imagining to analyze problems can be more focused so teachers need to familiarize students so that their application in learning using test questions instruments with problem-solving types is further improved and get used to.

There are several instruments can be used to analyze and determine student problem-solving abilities. Ability to measure problem-solving can be assessed through a test instrument in the form of questions that contain problems [12, 22]. One model of the problem-solving instruments is IDEAL [23, 24]. Bransford & Stein (1993) introduce IDEAL problem solving as a model that can help students to solve a problem. IDEAL stands for I-Identify problem, D-Define goal, E-Explore possible strategies, A-anticipate outcomes and act, L-look back and learn. In particular, IDEAL problem-solving can be used to solve a well-defined (well-structured) problem. The instrument in IDEAL contains the five stages: (1) identifying problem, (2) defining goal, (3) exploring solution, (4) implementing strategy, (5) reviewing and evaluating the impact of influence (Fig. 1). From the stages of the IDEAL problem-solving model, it is explained that the model can explore students' creativity in solving problems [25].

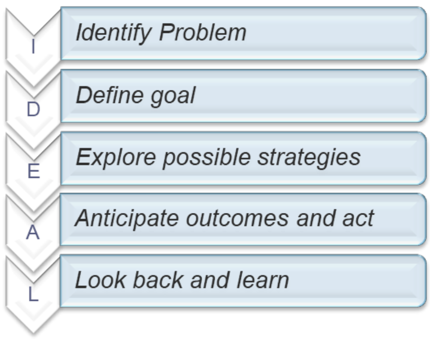

Fig. 1. Flowchat IDEAL

One of the characteristics of science material based on the context of the problem is chemistry, especially in acid-base solution, hydrolysis, buffers, and titration [26-29] .The study materials for acid-base solutions, hydrolysis, buffers, and titrations are deemed appropriate to use a problem-based learning design because these concepts are very close to everyday life which can be a "problem" in the learning stages that commonly occur in real life [30]. Thus, problem-solving abilities and learning outcomes as well as mastery of concepts will develop, because in the process of problem-based learning the students themselves will find and build a concept. The concepts built by students can be applied to solve various related problems because in chemistry learning students are not only required to understand chemical concepts, but they must also be able to apply the concepts they understand to solve problems [31]. Teaching that uses reality in everyday life can improve students' understanding and make chemistry class more interesting and fun [32].

Based on the description above, this study aimed to design and determine the quality of the instrument on acid-base material (e.g. acid-base, hydrolysis, buffer solution, and titration) using the IDEAL problem-solving model. Then, the designed instrument can be used to identify and solve problems and their urgency in the problem-solving process on acid-base materials.

2. Material and Methods

This research uses development research method which is often known as Research and Development (R&D). The instrument development model used in the study adapted the ADDIE model by Branch (2009) with five steps, namely (1) Analyze (analysis), (2) Design (planning), (3) Develop (development), (4) Implement (implementation), (5) Evaluate (evaluate) [33]. The research from the first stage to the fifth stage was carried out for 4 months (February – May 2022). The research from the first stage to the fifth stage was carried out for 4 months (February – May 2022) at SMAN 3 Sidoarjo

The research procedure was carried out using the following steps. First, the analysis was carried out by conducting a literature study on indicators and ways of assessing student problem-solving. Second, planning the development of test instruments by determining the indicators to be used. Third, the development includes the preparation of item indicators from basic competence (acid-base material, hydrolysis, buffer solution, and titration), preparation of question grids, preparation of questions and answer keys accompanied by scoring guidelines and preparation of expert validation guidelines. Fourth, is the implementation of the instrument to test the problem-solving ability of high school students. Fifth, evaluation is carried out at each stage so that the instruments developed are feasible to be applied in identifying students' problem-solving abilities.

At the development stage, expert validation was carried out to determine the suitability of the items with indicators, use of language, and the correctness of the concept as well as obtain suggestions for instrument improvement. The expert validators in this study were two high school chemistry teachers. Instruments that have passed expert validation then empirically validated to determine the validity, reliability, level of difficulty and discriminating power of items. Expert validation data analysis was carried out qualitatively by reviewing the validator's suggestions and quantitatively by calculating the average score given by the validator on each indicator. While the empirical validation data analysis was carried out quantitatively using the Pearson correlation and the Cronbach alpha test. The criteria used to interpret the data from the analysis can be seen in Table 1.

Table 1. Criteria for interpreting empirical validation data.

Difficulty Level		Power of Difference		Reliability		Validity	
Mark	Criteria	Mark	Criteria	Mark	Criteria	rxy-tab = 0.463	Criteria
0.00 – 0.30	Difficult	0.00 – 0.10	Bad	>0.90	Very high	Rxy > rxy-tab	Valid
0.31 – 0.70	Currently	0.10 – 0.30	Enough	0.81 - 0.90	High	Rxy < rxy-tab	Invalid
0.71 – 1.00	Easy	0.30 – 0.75	Good	0.61 - 0.80	Enough		
		0.75 – 1.00	Very good	0.41 - 0.60	Low		
		Negative	It is not in accordance with	<0.40	Very low		

Questions that have passed the experts and empirical validation tests can be used in the implementation phase to identify students' problem-solving abilities. The implementation subjects in this study were 34 students of grade 11 at a Public High School in Sidoarjo City. The data obtained are quantitative data in the form of student scores at the time of implementing the instrument and the results of student questionnaires. Data analysis of student scores was carried out by calculating the percentage of students' problem-solving skills for each indicator on each item. Then do the interpretation of the results of student answers qualitatively by explaining the ability of students to solve problems in the questions. Interpretation of qualitative data was carried out to determine the level of difficulty of students in answering questions. The results of student questionnaires were analyzed quantitatively to determine the percentage of implementation of problem-solving-based learning carried out by teachers and students' understanding of the learning process carried out on acid-base

3. Results and Discussion

IDEAL Type Problem Solving Instrument

This study developed an IDEAL-based problem-solving ability test instrument in the form of four structured description questions aimed at measuring the problem-solving abilities of high school students on acid-base, hydrolysis, buffer solution, and acid-base titration materials. The development procedure used in the research is five stages of ADDIE. The five stages used to consist of analyze, design, develop, implement, and evaluate.

The development of the problem-solving ability test instrument was carried out based on the previously selected indicators. Based on these five indicators, four questions were developed with details as shown in the IDEAL item. IDEAL problem-solving is designed to help identify and understand the different parts of problem-solving, each letter representing an important component in the problem-solving process. The explanation of each IDEAL indicator is as follows.

Identify a Problem

The problem identification indicator presents a scenario or description of the problem and students are asked to identify the problem that needs to be solved. For example, question number 1a presents a problem regarding the phenomenon of disposing of factory waste in rivers. In this indicator students can identify the problem of factory waste in depth.

Define Goal

Indicators of defining the problem are expected that students can uncover facts related to the problem so that solutions can be found. For example, in question number 1b students are asked to formulate problems and make hypotheses based on previously identified problems. In this indicator students can have the ability to determine the concept or purpose, determine information/data related to the given problem, and determine the details of the problem.

Explore Possible Strategies

Indicators exploring possible strategies are expected so that students can plan a solution to a problem. For example, in question number 1c students are asked to write down the steps in determining the pH of factory waste. In this indicator, students can have the ability to develop problem-solving plans and choose the right theories, principles, and approaches to solve related problems.

Anticipate Outcome and Act

Indicators anticipate results and actions are expected students can take action for a strategy or plan that has been made. For example, in question number 1d students are asked to calculate the approximate pH using the pH route according to the steps that have been made in problem 1c. In this indicator, students can have the ability to make a list of problems to be solved and sequence the work steps related to the solutions that have been made.

Look Back and Learn

The indicator sees the consequences of the strategy used, it is hoped that students can learn from the experience gained (evaluation). For example, in question number 1e students are asked to conclude whether factory waste is appropriate to be dumped into the river after knowing the approximate pH of the waste. In this indicator students can have the ability to check the feasibility of the solutions made, make assumptions regarding the solutions made, and estimate the results that will be obtained through the solutions that have been made. The questions that have been developed are presented in Figure 2.

Validity and Reliability

The four structured questions that have been developed are then validated by experts. Expert validation was carried out by two Chemistry teachers at a Public High School in Sidoarjo City. Validation is carried out to obtain an assessment covering seven aspects, namely (1) the suitability of the items with indicators of competency achievement, (2) the suitability of the items with the material, (3) the suitability of the items with the formulation of indicators, (4) items that use an easy language. understood, (5) the item contains the stages of problem-solving, (6) the item does not cause multiple interpretations, and (7) the defined concept is relevant to the level of education of students.

Based on the results of expert validation presented, it was found that all of the items were in the very good category so that they were very feasible to use. The suggestions obtained from the experts are presented in Table 2.

Table 1. Expert advice.

Question points	Suggestion
1	The name of the compound or the name of the acid-base indicator is written in full, not abbreviated, paying attention to the rules of capitalization, paying attention to the sign or notation of the question
2	Chemical notation is considered again, for example concentration
3	Problems may be added pictures/illustrations
4	The titration curve on the key is fixed with the x-axis and y-axis information

The suggestions obtained are then used as considerations in revising the problem-solving ability test instrument. An example of the results of the instrument revision is presented in Fig. 2a and 2b. The revised instrument is then empirically validated.

1. Watch the events below!

(Phenomenon of factory waste disposal in the river)

According to the Decree of the Minister of Environment No. Kep 03/ MNKLH/ II/1991, it is stipulated that factory X wastewater may be discharged into river waters or into other environments, if the pH of the wastewater is in the range of 6-9. pH is a chemical water quality criterion. In addition to chemical quality, physical and biological quality are also criteria for water quality. If it is known the color change trajectory of several indicators as follows:

INDICATOR	pH TRAY	DISCOLORATION
MO	3.1 – 4.4	RED YELLOW
MR	4.4 – 6.2	RED YELLOW
BTB	6.0 – 7.6	YELLOW – BLUE
PP	8.3 – 10.0	TBW – RED

Fig. 2a. Sample introduction to problem.

a. Based on the above phenomenon, identify the problems facing factory X!

....

....

....

b. Based on the phenomenon above, make a proper problem statement for the phenomenon and make a hypothesis!

....

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c. Based on the above phenomenon, please help factory X to make steps to solve the pH determination of the waste!

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d. The results of the experiments carried out by the factory were that the X waste when tested with MO and BTB was yellow, with MR it was orange and colorless with PP. Calculate the approximate pH according to the work steps in step c.

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....

e. Based on your analysis in step d, give a conclusion about waste X can be dumped directly into the river or need further waste treatment!

....

....

....

Fig. 2b. Examples of the stages of IDEAL type problem-solving questions.

Empirical validation was carried out based on data from the test results of 34 high school students at grade 11 using an instrument that had been revised according to expert advice. Students who became the participants were students who already had knowledge of acid-base material and inorganic functions. Several tests were used to see the validity of the instrument, including the level of difficulty of the items, the differentiating power of the items, validity, and reliability.

The data obtained show that the questions on the concept of a buffer solution have an easy level of difficulty, while the questions on the concepts of acid-base, salt hydrolysis, and acid-base titration have a moderate level of difficulty. Good questions are questions that are not too difficult and not too easy [34]. This shows that the questions developed have met the criteria with a moderate level of difficulty category. However, special attention needs to be paid to the third question about the concept of a buffer solution because it is still relatively easy for students. The results of the calculation of the difficulty level of the items can be seen in Table 3.

The data obtained also shows that the average discriminatory power of the items is moderate. Problems on the concept of acid-base titration have good distinguishing power, while questions on the concept of acid-base, salt hydrolysis, and buffer solutions have moderate differences. This shows that the IDEAL type of problem-solving instrument can be used to separate student achievement. The results of the calculation of the differentiating power of items can be seen in Table 3.

Table 3. The results of calculating the level of difficulty and differentiating power of items.

No	Difficulty Level	Criteria	Power of Difference	Criteria	Status
1	0.60	Currently	0.38	Good	Fixed
2	0.66	Currently	0.24	Enough	Fixed
3	0.81	Easy	0.33	Good	Enough/Fixed
4	0.57	Currently	0.53	Good	Good/Accepted

The validity of the items was carried out by using Pearson Product Moment correlation analysis (Bivariate Pearson). The validity results obtained indicate that the four-item items are declared valid because $r_{xy} > r_{table}$. R_{table} used for the number of samples 34 is 0.463. The results of the r_{xy} calculation for each item can be seen in table 4. In addition, the reliability of the instrument was also calculated using Cronbach's Alpha with a significance value of 5%. The results of the reliability calculation show that the value of Cronbach's Alpha on the IDEAL type of problem-solving instrument is 0.623. This value indicates that the developed instrument has sufficient reliability to test the problem-solving abilities of high school students.

Table 4. The results of the analysis of the validity and reliability of the problem-solving instrument.

No	Rxy	Interpretation	Reliability	Interpretation
1	0.700	Valid	0.623	Reliable enough
2	0.624	Valid		
3	0.655	Valid		
4	0.768	Valid		

Student's IDEAL Problem-Solving Ability

This study aims to determine the profile of students' problem-solving skills with the IDEAL model carried out in class XI on acid-base materials, salt hydrolysis, buffer solutions, and acid-base titrations. Well-structured problem-solving skills test instrument consists of 5 questions with 5 IDEAL stages, including (1) Identify the problem (define the problem), (2) Define the goal (define the goal), (3) Explore solution (exploring solutions), (4) Act on strategy (implementing the strategy), (5) Look back and evaluate the effect (review and evaluate the impact) [23], [25]. The results of student answers consisted of 4 questions from 4 materials, each consisting of 1 item with a total score of 100 where 1 question each has a maximum score of 25. After all student answers are corrected and scored, the next step is to process the total score obtained. obtained by students by dividing it by a maximum score of 100, then multiplied by 100. The scores obtained by students are then grouped into categories of problem-solving abilities as shown in the following table 5:

Table 5. Value of student Problem-Solving skills.

Student value	Category	Frequency	Percentage
81-100	Very good	3	8.82%
61-80	Well	20	58.82%
41-60	Enough	9	26.47%
21-40	Not enough	2	5.88%
0-20	Very less	0	0
Amount		34	

In addition, students were also asked to fill out a questionnaire consisting of 11 questions and conduct short interviews with researchers regarding students' problem-solving skills on acid-base, salt hydrolysis, buffer solutions, and acid-base titrations.

Level of Student Problem-Solving Skills on Acid-base Materials

Based on the results of students' answers to the problem-solving skills test, it can be obtained a score for each student's problem-solving skills for question number 1 on acid-base material. The test questions consist of 1 question with 5 IDEAL stages which are done individually. The results of student answers are scored according to the scoring rubric that has been made. The maximum score for question number 1 is 25 where each indicator has a different level of difficulty so that each indicator has a different score, namely from the IDEAL stages, which have a score of 3, 3, 7, 8, and 4. Then to find out the percentage of occurrences IDEAL problem-solving indicators of student answers to the test questions given can be seen in the Fig. 3.

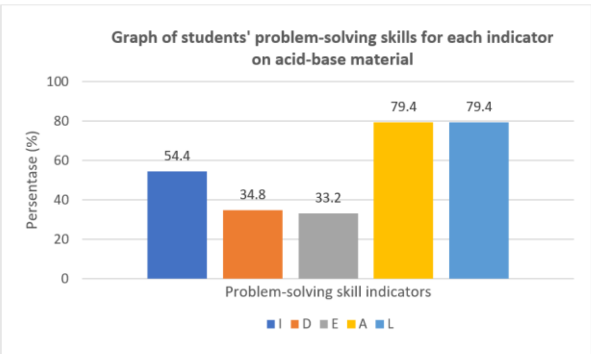

Fig. 3. Graph of students' problem-solving skills for each indicator on acid-base material

Based on the graph, it can be seen that the problem-solving skills of students on acid-base material, the D-Define the goal indicator or defining the goals and indicators of the E-Explore solution or digging for solutions, can be said to be still low, namely 34.8% and 33.2%, respectively. Students have not been able to determine the formulation of problems and hypotheses and students are also not able to describe strategies or appropriate steps in solving problem-solving problems on acid-base material. This happens because students have not been able to understand the meaning of the problem and have not fully mastered the concept of acid-base so they have difficulty in determining the formulation of the problem, hypotheses, and describing the steps. However, on the I-Identify the problem indicator or define student problems of 54.4% can identify problems on acid-base problems. While on the A-Act on strategy indicator or implementing the strategy and L-Look back and evaluate the effect indicator or reviewing and evaluating the impact of 79.4% students can formulate problem-solving strategies appropriately and students can conclude correctly the problems given in question.

Student's Problem-Solving Skill Level on Salt Hydrolysis Material

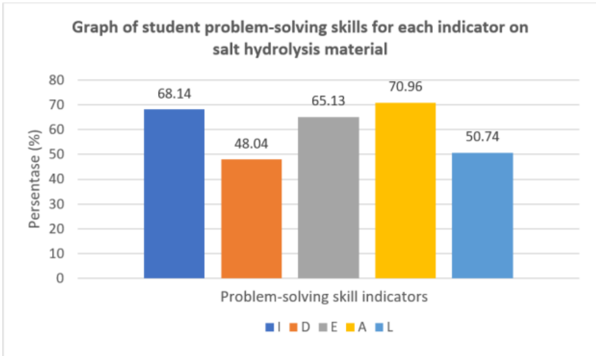

Fig. 4. Graph of student problem-solving skills for each indicator on salt hydrolysis material.

Based on the graph of the Fig. 4, it can be seen that students' problem-solving skills on the salt hydrolysis indicator material I-Identify the problem or defining the problem by 68.14% of students can identify problems by proving true or false statements about salt whose cations come from group IA will be alkaline. but has not been able to provide an explanation why the statement is true and false. Meanwhile, the D-Define the goal indicator or defines a goal of 48.04% which is able to give the right reason about a salt solution can be acidic or basic. However, in the E-Explore solution indicator or exploring solutions students are able to make steps to calculate pH of 65.13%. This is because students understand how to calculate pH but have not been able to master the concepts of acid salt and base salt well. In the A-Act on strategy indicator or implementing a strategy, 70.96% of students are able to rank the pH from low to highest from the previous data, but on the L-Look back and evaluate the effect indicator or review and evaluate the impact of 50.74% students have not able to conclude well the differences in the properties of acid salts and basic salts.

Student's Problem-Solving Skill Level on Buffer Solution Material

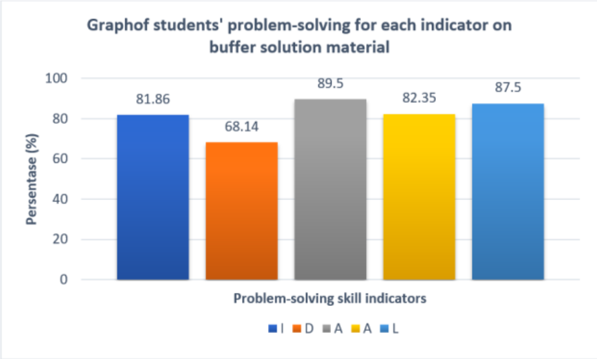

Fig. 5. Graph of students' problem-solving skills for each indicator on buffer solution material.

Based on the graph (Fig. 5), it can be seen that the students' problem-solving skills on the buffer solution material from the five IDEAL indicators can be said to be good and very good. In the I-Identify the problem indicator or defining the problem, 81.86% of students are able to relate and identify the problem in the problem with the concept of a buffer solution. In the D-Define the goal indicator or defining goals, 68.14% of students are able to describe the buffer solution. However, some students have not been able to give an accurate description of the buffer solution. On the indicators of E-Explore solution or exploring solutions, A-Act on strategy or implementing strategies, and indicators of L-Look back and evaluate the effect or review and evaluate the impact with students of 89.5%, 82.35%, and 87.5% in a row students were able to provide a description of the concept of a buffer solution. This proves that most of the students' buffer solution material is able to compile steps to make acid and alkaline buffer solutions, make buffer solutions with a certain pH, and can also conclude the working principle of buffer solutions well.

Table 6. Questions and responses from students.

No.	**Question**			**Score**		
				Yes		**No**
1.	Are you aware of problem-solving based learning methods?			97%		3%
2.	Do your teachers apply problem-solving-based learning methods in class?			91%		9%
3.	Do the evaluation questions or assessment instruments for acid-base materials apply based on problem-solving?			100%		0
4.	Are the evaluation questions or assessment instruments for buffer solution material based on problem-solving?			100%		0
5.	Are the evaluation questions or assessment instruments for salt hydrolysis material based on problem-solving?			100%		0
6.	Are the evaluation questions or assessment instruments for acid-base titrations based on problem-solving?			100%		0
No.	Question			**Score**		
				Yes	**No**	**Enough**
7.	Can you solve a problem in Chemistry?			29%	3%	68%
No.	**Question**	**Score**				
		Do not understand	**Not really understand**	**Understand enough**	**Understand**	**Very Understand**
8.	How do you understand the acid-base material given by the teacher in class?	-	3%	20%	59%	18%
9.	What is your understanding of the buffer solution material given by the teacher in the classroom?	3%	3%	44%	38%	12%
10.	How do you understand the hydrolysis material given by the teacher in the classroom?	3%	6%	29%	47%	15%
11.	What is your understanding of the acid-base titration material given by the teacher in the classroom?	3%	9%	41%	38%	9%

Level of Student Problem-Solving Skills on Acid-base Titration Materials

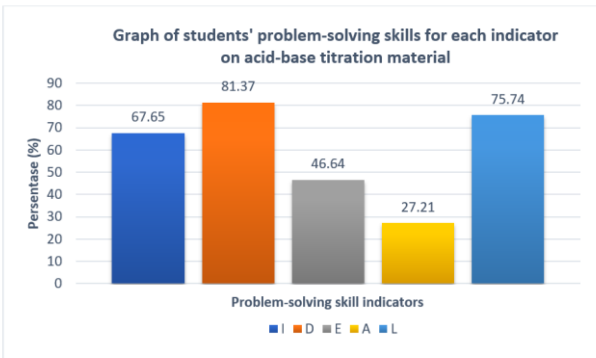

Fig. 6. Graph of students' problem-solving skills for each indicator on acid-base titration material.

Based on the graph (Fig. 6), it can be seen that the problem-solving skills of students on acid-base titration material on the I-Identify the problem indicator or defining the problem of 67.65% of students are able to calculate the volume of Ammonium hydroxide to neutralize 20 mL of 0.01 M hydrochloric acid. In the D-Define the goal indicator or defining goals, 81.37% of students were able to determine the endpoint of the titration. However, on the E-Explore solution indicator or exploring student solutions, 46.64% of students found it difficult to determine the pH when adding 20.2 mL and 20.5 mL so there was a decrease in the percentage of the A-Act on the strategy indicator or implementing student strategies of 20.2 mL and 20.5 mL 27.21% Most of them misrepresent the curve and determine the correct pH equivalent.

Student Questionnaire Results

Based on the results of filling out a questionnaire by 34 students of class XI regarding the experiences of students in the application of problem-solving skills on acid-base materials, salt hydrolysis, buffer solutions, and acid-base titrations, the following table shows the answers to the 11 questions given.

Based on Table 6, it can be seen that most students know problem-solving-based learning methods or problem-solving. According to students, their teachers have implemented problem-solving-based learning methods, as well as the assessment system and learning evaluation tests used by teachers are also problem-solving-based. However, in practice, only 10 students felt they were able to solve a problem in chemistry and 23 students felt they were quite capable of solving problems in chemistry. Meanwhile, for the acid-base material, there were 6 students who really understood the material presented by the teacher, 20 students who understood it, and 7 students who quite understood the material presented by the teacher. In salt hydrolysis materials, buffer solutions, and acid-base titration most students understand and quite understand the material presented by the teacher. This is in line with the results of students' problem-solving abilities because on average students can be able to solve problems in problems although in practice they still need guidance and habituation in applying methods in practicing problem-solving skills by students, especially in chemistry [10].

4. Conclusions

Based on the analysis and the results of student work, it is known that the problem-solving skills of State Senior High School students in Sidoarjo City are mostly in the good category. The problem-solving skills of 20 students can be categorized as good, 3 students are in the very good category, 9 students are in the fairly good category, and 2 students are in the poor category. Indicators of problem-solving skills obtained the highest percentage is found in the A-Act indicator on strategy and L-Look back and evaluate the effect indicator at 79.4%. Indicators of problem-solving skills obtained the highest percentage is found in the A-Act indicator in the strategy of 70.96%. The indicator of problem-solving skills obtained the highest percentage on the E-Explore solution indicator of 89.5%. Indicators of problem-solving skills obtained the highest percentage is found in the D-Define indicator, namely the goal indicator of 81.37%.

Author Contributions

The contribution of the first author is to provide direction regarding the limitations of the cited journals to be used as literature to use as basis. The second author's contribution is writing articles and providing new interpretations of every reference in the article to use as a research basis. The third author's contribution is correcting the contents of the article and making improvements to the format as well as making publications. The fourth and fifth author's contribution is controlling the writing of articles so that they comply with the guidelines for writing good and correct papers.

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