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Improving Vocational Skills and Learning Outcomes through Entrepreneurship-Based Chemistry Learning

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Abstract: Vocational skills are one of the skills that students must have in facing today's industrial world. Therefore, schools should provide lessons that can improve students' vocational skills. One way to develop vocational skills is through chemistry learning based on Chemo-entrepreneurship (CEP). This research aims to determine the influence of CEP-based chemistry learning on students' vocational skills and learning outcomes. The method used in this research was a quasi-experiment with a pretest-posttest control group design. This research was conducted at MAN 1 Rembang. The research sample consisted of 48 students consisting of 23 students as the control group and 25 students as the experimental group. The research results showed that the N-gain of vocational skills in the control group was 0.31 while the experimental group was 0.55. The N-gain of the control group's learning outcomes was 0.04 while the experimental group was 0.53. The results of the t test for vocational skills and learning outcomes obtained a score of t count > t table (2.01), namely 3,462 and 6,932. The conclusion of this research is that CEP-based chemistry learning has a positive influence in improving vocational skills and student learning outcomes.

Keywords: CEP; Entrepreneurship; Learning; Sciences; Vocational skills

Introduction

Education has a very important role in creating superior human resources. Superior human resources are the main key in facing intense job competition. Creating superior human resources is one alternative in overcoming poverty in Indonesia. Based on data from the Central Statistics Agency, it is known that the amount of poverty that occurred in Indonesia in the last three years (2020-2022) was dominated by vocational and high school graduates. This shows that the number of job vacancies available is not comparable to the number of job seekers who are vocational and high school graduates. Apart from that, one of the causes of great poverty is low skills (Sakdimah et al., 2018).

To overcome the high unemployment rate of vocational and high school graduates, schools need to plan special steps to provide vocational skills to students. Vocational skills are one of the life skills that train students to be able and brave in facing life's problems, then they can creatively solve the problems they face (Prayitno et al., 2020). Vocational skills can be trained and developed through classroom learning activities.

Learning activities are a process of student interaction with teachers and learning resources in a learning environment. Through learning activities a person can gain knowledge, experience and skills to achieve the desired goals. A teaching and learning activity is said to be good if the teaching and learning process takes place effectively, there is a reciprocal relationship between the teacher and students, and can influence student learning outcomes (Alwiyah & Imaniyati, 2018). Student learning outcomes are not only in the form of cognitive values but also psychomotor and affective values.

Based on the results of interviews with several MAN 1 Rembang students, information was obtained that chemistry is a complex subject because apart from studying theories and formulas, chemistry also teaches

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about chemical reaction equations. Chemistry practicum for making chemical-based entrepreneurial products has never been carried out. As a result of interviews with Chemistry teachers, information was obtained that the average student learning outcome score in the Final Semester Assessment was 57.75. Apart from that, not all MAN 1 Rembang alumni students go on to college.

Based on this description, a learning innovation is needed that can equip vocational skills and foster student learning motivation. Increasing student learning motivation will indirectly have an impact on better student learning outcomes. One type of learning that can provide life skills and improve learning outcomes is Chemo-entrepreneurship based chemistry learning (Setyaningsih et al., 2021; Zia Ulhaq et al., 2021; Sakdimah et al., 2018). Chemo-entrepreneurship based chemistry learning is a chemistry learning method that is carried out by transferring knowledge and skills in processing raw materials into valuable products by applying the chemical theory learned (Dewi & Mashami, 2019). Through CEP-based chemistry learning, students are trained to develop vocational skills through practicums in making household products such as making dishwashing soap, shampoo, etc.

CEP-based chemistry learning is learning carried out through practical work related to chemical entrepreneurship. Learning begins with analyzing problems based on the material studied, determining business opportunities based on the problems found, planning product creation according to the results of opportunity analysis, product creation, product packaging, and product marketing. Through this learning, students are expected to be active and creative in determining chemical entrepreneurship ideas based on an analysis of problems in life that are related to the material being studied.

The learning process which is linked to everyday life phenomena makes it easier for students to understand the material being studied, because students learn in real terms so that students' learning motivation increases (Prayitno et al., 2017; Sumarti et al., 2018). Good student learning motivation will influence enthusiasm for learning and foster students' love for the subject of chemistry. As a result, student learning outcomes (cognitive, psychomotor and attitude) experienced changes in a positive direction.

On the other hand, research on CEP-based learning on vocational skills has never been carried out. Based on the results of the analysis of several articles, research that has been carried out related to CEP includes the development of CEP-based chemistry modules (Wijayanti et al., 2020; Arfin et al., 2018; Pinta et al., 2018; Setyaningsih et al., 2021; Sakdimah et al., 2018; Annisa & Sari, 2021), the influence of CEP learning on collaboration and communication skills (Paristiowati et al., 2015), the influence of CEP learning on collaboration and communication skills (Sumarti et al., 2018; Purnama et al., 2020; Zia Ulhaq et al., 2021), and the influence of CEP learning on creative thinking skills (Hartini & Azizah, 2019; Sutarto et al., 2021). Based on this analysis, research on the effectiveness of CEP-based learning on vocational skills needs to be carried out to find out how much influence CEP-based chemistry learning has on vocational skills and student learning outcomes.

Method

We use a quasi-experimental research method with a pre-experimental design that focuses on the effect of chemo-entrepreneurship learning on students' vocational skills and learning outcomes. This research aims to determine the improvement of vocational skills and student learning outcomes. The data in this research are indicators of students' vocational abilities which can be measured through students' abilities in completing designed tests. The research design used was a pretest-posttest control group design (Sugiyono, 2009). The shape of the design is illustrated in Table 1.

Table 1. Pretest-Posttest Control Group Design

Group	Pretest	Action	Posttest
Experiment	O_1	X	O_2
Control	O_3	-	O_4

This research was carried out at MAN 1 Rembang. The sample from this research was class 11 IPA-3 with a total of 23 students as the control class and class 11 IPA-4 with a number of 25 students as the experimental class. Variables in the experimental class were treated with a CEP-based learning model, while the control class was treated with a practicum model as contained in the chemistry book. The independent variable in this research is the CEP learning model, while the dependent variables are vocational skills and learning outcomes.

The data obtained are in the form of quantitative data. The data collection method used in this research is the test and observation method. The data collection instruments in this study were learning achievement test questions and vocational skills observation sheets. The study result questions were prepared based on indicators on competency standards for acid-base materials, while the observation sheets were prepared based on indicators of vocational skills which included skills at work, skills in using tools, and compliance with occupational safety and health procedures. Other instruments used in this research are learning support devices such as syllabi, lesson plans, and CEP-oriented chemistry modules, which material experts and media experts have validated. The data analysis techniques used were the normality test, homogeneity test, validity and reliability test of items, N-gain, and t-test. The gain analysis equation (Hake, 1998) is shown in equation 1 with the modified N-gain criteria as shown in Table 2.

$$N_{-gain} = \frac{Postscore - Prescore}{100 - Prescore} \quad (1)$$

Table 2. Criteria for Improving Learning Outcomes

N-gain	Category
0 – 0.15	Very Low
0.16 – 0.30	Low
0.31 – 0.50	Medium
0.51 – 0.70	High
0.71 – 1.00	Very High

Result and Discussion

The results of the research include the results of observations of vocational skills and the pretest and posttest scores of student learning outcomes. The learning model in the sample class is divided into two: the practicum-based learning model referring to the chemistry book for the control class, and the experimental class being given a CEP practicum-based learning model, such as making household products such as plates, soap, and shampoo.

Before the lesson started, the two samples were made with initial observations of students' vocational skills and a pretest of learning outcomes. The observation is to determine the vocational skills and students' initial understanding of acid-base material. Students' initial vocational skills are known by providing a vocational skills questionnaire with instructions and an assessment rubric in filling out the questionnaire. The average result of initial observation of vocational skills in the control group was 73.04, while in the experimental group was 62.93. The pretest of learning outcomes was carried out by giving 20 multiple-choice questions declared valid. The pretest results obtained the average learning outcomes of the control group at 19.78 and the average learning outcomes of the experimental group at 20.40.

After the pretest, the samples were then given regular learning. The learning activities process follows the steps contained in the lesson plans in general. The experimental group was given additional CEP practicum, starting from product manufacture to product sales, but the control group was not.

After the process of teaching and learning activities have been completed for several meetings, the next step is to give a post-test to students. The observation of vocational skills after the learning took place obtained a mean score of 81.45 for the control group and 83.47 for the experimental group. The control group's average posttest of learning outcomes was 23.91, and the average posttest of the experimental group was 63.60. The results of the recapitulation of students' vocational skills based on indicators of vocational skills learned in the control and experimental group are presented in Table 3.

Table 3. Results of Vocational Skills Recapitulation

Vocational skill indicators	Control		Experiment	
	Pre	Post	Pre	Post
Accurate in the workplace	79.13	85.22	61.60	80.80
Skills in using chemical equipment	72.17	80.00	61.60	84.80
Compliance with OHS procedures	67.83	79.13	65.60	84.80
Average	73.04	81.45	62.93	83.47
N-gain Category		0.31 (medium)		0.55 (high)

The vocational skills research results show that the control group's average pretest score is higher than the experimental group. This result shows that before treatment was given, the control group had better vocational skills than the experimental group in terms of accuracy in work, skills in using laboratory equipment in practice, and working according to OHS standards. This value finding differs from the average value of vocational skills at the posttest time. The posttest results showed that the average vocational skill of the experimental group was higher than that of the control group. The increase in the average vocational skills in the experimental group, which is better than the control group, shows that CEP learning can improve students' vocational skills.

Each indicator of vocational skills in the experimental group experienced an increase based on the N-gain index, which was higher than the control group. The increase in the score of work accuracy in the experimental group was 0.49 in the medium category, while in the control group, it was 0.28 in the low category. Improving students' skills in using assistive devices in the experimental group reached 0.48 in the medium category, while improved skills in using assistive devices in the control group were 0.21 in the low category. Likewise, the improvement of work processes or work procedures concerning Occupational Health and Safety showed that the experimental group had an increase of 0.50 in the high category, while the control group was in the 0.36 category in the medium category. The average increase of these three aspects in the experimental group was 0.60 in the high category and 0.28 in the control group in the low category. The improvement of vocational skills in the experimental and control group can be seen in Figure 1.

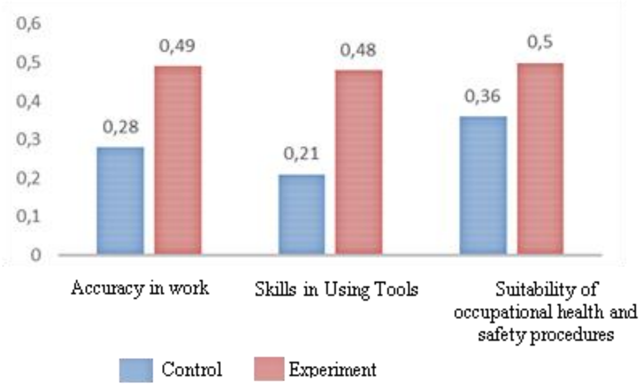

Figure 2. Vocational skills improvement chart

The results of the t-test of vocational skills obtained t count value of 3.46, while the table value of 2.01. The results of the vocational proficiency t-test are presented in Table 4.

Table 4. Vocational Skills T-Test Results

		Levene test		
		F	Sig	t
Vocational Skill	Equal variances assumed	3.855	0.056	3.462
	Equal variances not assumed			3.402

The value of t count > t table indicates that there is a significant difference between the vocational skills of the control group and the experimental group. The improvement of vocational skills in the experimental group shows that CEP learning can improve students' hands-on skills. CEP learning gives students the freedom to be creative and communicate with others. Chang et al. (2013) stated that the development of entrepreneurial skills could be improved by providing an authentic learning environment so that students can interact directly with people with an entrepreneurial spirit.

Ekwueme et al. (2015) suggest that learning by emphasizing practicum will provide opportunities for students to demonstrate their knowledge and skills, motivating them to participate in teaching and learning activities. CEP-based learning can make students more active in learning, creative in solving problems, making products, and practice being entrepreneurs (Amalana et al., 2019). Sardiman (2016) suggests that activities are needed in teaching and learning activities because, in principle, learning is doing (or learning by doing). Students will find this learning interesting because they are free to be creative and express ideas in manufacturing, packaging, and marketing products. Engaging learning and students doing it themselves will motivate them to produce products; students are active in communicating both verbally and in writing, cooperating, and proficiently selling their expertise products (Wijayati & Rengga, 2009).

Student learning outcomes data were taken through pretest and posttest. Before learning starts, students are given a pretest of multiple-choice questions regarding acid-base material; as many as 20 questions are declared valid with a reliability value of 0.944 in the very high category. The question indicators used for the pretest and posttest can be seen in Table 5.

Table 5. Indicators, Level of Difficulty, and Separation Power of Test Items

Indicator Question	Level of Difficulty		Unique Power	
	Score	Category	Score	Category
Acids according to Arrhenius	0.5	Medium	1.0	Good
Bronsted-Lowry acid-base compounds	0.7	Medium	0.7	Good
Conjugated acid-base ion pair	0.3	Difficult	0.5	Good
pH of strong acid solution	0.2	Difficult	0.3	Good
pH of strong base solutions	0.4	Medium	0.6	Good
pH of strong base solutions	0.3	Difficult	0.3	Good
Determination of acid (Ka)	0.5	Medium	0.7	Good
pH of weak acid	0.6	Medium	0.8	Good
pH of weak base	0.5	Medium	0.5	Good
pH of weak acid	0.6	Medium	0.7	Good
pH of weak base	0.3	Difficult	0.3	Good
Ion concentration of weak acid	0.8	Easy	0.5	Good
Color change trajectory	0.5	Medium	0.9	Good
Color change trajectory	0.4	Medium	0.7	Good
Determination of base (Kb)	0.5	Medium	0.6	Good
Concentration of acid if pH and Ka are known	0.4	Medium	0.4	Good
Degree of ionization of acid	0.3	Difficult	0.6	Good
Ion concentration of weak base	0.6	Medium	0.7	Good
Ion concentration of weak acid	0.5	Medium	0.6	Good
Acid or base of a compound	0.3	Difficult	0.5	Good

After the pretest was carried out on the two sample groups, the average pretest, posttest, and N-gain index scores were obtained as shown in Table 6.

Table 6. Results of Pretest, Posttest, and N-gain

Group	Pretest	Posttest	N-gain	Category
Control	19.78	23.91	0.04	Low
Experiment	20.40	63.60	0.53	High

Student learning outcomes in control and experimental groups were also carried out with t-tests using SPSS analysis. T-test to determine whether student learning outcomes were taught with CEP practicum and non-CEP practicum after normality and homogeneity test were performed. Based on the results of the normality test using the Kolmogorov-Smirnov One-sample test. The results of the sample normality test are shown in Table 7, while the homogeneity test and t-test are shown in Table 8.

Table 7. Normality Test Results

		Learning Outcomes
N		48
Normal Parameters (a,b)	Mean	.2969
	Std. Deviation	.34919
Most Extreme Differences	Absolute	.136
	Positive	.136
	Negative	-.075
Kolmogorov-Smirnov Z		.940
Asymp. Sig. (2-tailed)		.340

Table 8. Results of Homogeneity Test and T-Test

		Levene test		
		F	Sig	t
Learning Outcome	Equal variances assumed	6.426	0.015	6.781
	Equal variances not assumed			6.932

Based on the normality test results, the sig value (0.940) > 0.05, meaning the data is typically distributed. The homogeneity test obtained a sig value (0.015) <0.05, which means the data is not homogeneous. After the data were analyzed for the normality and homogeneity tests, the data was carried out by t-test. Based on the t-test analysis obtained t count > t table. The t count value is 6.93, while the t table value is 2.01. This means there are differences in student learning outcomes in the experimental and control groups. CEP learning can improve students' academic abilities (Tukiran et al., 2017). The increase in learning outcomes in the control group was 0.04 in the low category, and the experimental group was 0.53 in the high category. The increase in the experimental group's learning outcomes was higher than the control group because CEP learning could increase students' activities in discussing, asking questions, thinking critically and creatively, and caring for others. In addition, chemistry learning packaged in the CEP learning model becomes more attractive and meaningful, motivating students to participate in learning activities properly (Fuldiaratman & Ekaputra, 2023).

The improvement in student learning outcomes guided through CEP learning is better because learning through the application of life skills can change the view of learning, which is only oriented to the number of chemistry learning materials (Hikmawati, 2015). Life skills-oriented chemistry learning can help students make decisions and solve problems appropriately, think critically and creatively, communicate effectively both orally and in writing, caring for others, and being able to manage their lives constructively (Prajapati et al., 2016). Based on the normality test results, the sig value (0.940) > 0.05, meaning the data is typically distributed. The homogeneity test obtained a sig value (0.015) <0.05, which means the data is not homogeneous. After the data were analyzed for the normality and homogeneity tests, the data was carried out by t-test. Based on the t-test analysis obtained t count > t table. The t count value is 6.93, while the t table value is 2.01. This means there are differences in student learning outcomes in the experimental and control groups. CEP learning can improve students' academic abilities (Tukiran et al., 2017). The increase in learning outcomes in the control group was 0.04 in the low category, and the experimental group was 0.53 in the high category. The increase in the experimental group's learning outcomes was higher than the control group because CEP learning could increase students' activities in discussing, asking questions, thinking critically and creatively, and caring for others. In addition, chemistry learning packaged in the CEP learning model becomes more attractive, motivating students to participate in learning activities properly (Wijayati & Rengga, 2009).

The improvement in student learning outcomes guided through CEP learning is better because learning through the application of life skills can change the view of learning, which is only oriented to the number of chemistry learning materials (Lelono & Saptorini, 2015). Life skills-oriented chemistry learning can help students make decisions and solve problems appropriately, think critically and creatively, communicate effectively both orally and in writing, caring for others, and being able to manage their lives constructively (Prajapati et al., 2016). Apart from that, implementing the CEP approach in learning can make the learning atmosphere more active and enjoyable, making chemistry learning less boring and giving students the opportunity to optimize their potential in producing a product. Learning using the CEP approach can increase students' creativity and interest or fascination with the material being studied so that it is hoped that it can improve learning outcomes (Nirwana & Yenti, 2021).

Atmojo et al. (2022) suggests that entrepreneurship-based learning has ten benefits, namely a) opening and growing new employment opportunities for others; b) improving the quality of community Life; c) increasing entrepreneurial spirit; d) increasing creativity; e) developing innovation; f) practicing discipline; g) practicing responsibility; h) having an honest nature; i) teaching children to become more independent; and j) having a high commitment and competitive spirit.

Conclusion

The results showed that the N-gain results of vocational skills in the experimental group were higher than those in the control group. The N-gain value for vocational skills in the experimental group was 0.55 in the high improvement category, while the N-gain value in the control group was 0.31 in the medium category. The results of the vocational skills t-test obtained a score of t count (3.462) > t table (2.01), which means that there is a difference between vocational skills in the experimental group and the control group. Results the N-gain value of the experimental group's learning outcomes was higher than the control group. The N-gain value of the experimental group's learning results was 0.53 in the high category, while the N-gain value for the control group was 0.04 in the low category. The results of the t test on learning outcomes obtained a t count score of 6.932 > t table (2.01), which means that there is a difference between chemistry learning outcomes in the experimental group and the control group. Based on the description above, it can be concluded that CEP-based chemistry learning is effective in improving vocational skills and student learning outcomes at MAN 1 Rembang.

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Conceptualization and methodology, Mohammad Agus Prayitno (M.A.P) and Nourma Yulita (N.Y.); formal analysis, N.Y..; investigation, M.A.P and N.Y.; writing-original draft preparation, M.A.P. and N.Y.; writing-review and editing, M.A.P.; Visualization. M.A.P. and N.Y. All authors have agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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