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Application of the PjBL Model to Chemical Materials to Improve Students' Creative Thinking Skills and Entrepreneurial Interests

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Abstract: Project Based Learning (PjBL) has many advantages but has not been widely implemented, let alone linked to entrepreneurial activities in schools. Entrepreneurship in schools, especially those taught by chemistry teachers, still has not produced crafts that link chemical knowledge therein. The aim of the research carried out was to analyze how much influence the application of the PjBL model has in improving students' creative thinking skills and entrepreneurial interest. The research method uses a one group pretest-posttest design approach. The research sample was selected using proportional sampling with data collection techniques, namely test techniques and distributing questionnaires which were then analyzed using the paired sample t test. Based on the results of the research that has been carried out, it can be concluded that there is a positive significant difference between before and after treatment. This shows an increase in students' creative thinking abilities and entrepreneurial interest after implementing the PjBL learning model.

Keywords: Creative thinking skills; Interest in entrepreneurship; PjBl model

Introduction

Education has an important role in improving the quality of human resources (Sadler et al., 2023; Smiderle et al., 2020). Professional teachers will strive to create innovative learning in order to produce an intelligent and competitive generation. Progress over time and technological sophistication have caused entrepreneurial trends to continue to change. However, the lack of skills is one of the reasons the ratio of people who become entrepreneurs in Indonesia is lower than in several countries in Southeast Asia (Lidwina, 2019). Individuals are not accustomed to high-level thinking, lacking creative, critical, analytical and problem-solving thinking skills (Khan et al., 2015). Learning chemistry is one of the lessons in Senior High School (SMA) which is responsible for preparing students with an entrepreneurial spirit. Entrepreneurship subjects (WU) provide skills to students, teach them to acquire skills and become entrepreneurs.

The industrial revolution 4.0 changes human thinking patterns and ways of doing activities. This requires an educational process with a creative, innovative, adaptive learning model, and capable of increasing graduate competency in accordance with the demands of 21st century competency needs (Stehle et al., 2019). It is important for students to have the ability to think creatively, so they are able to survive in uncertain and competitive conditions in the era of disruption (Soyadı, 2015; Sudarmin et al., 2019; Sumarni et al., 2016). Someone who has the ability to think creatively can be a powerful weapon for dealing with various types of problems because it opens students' eyes to seek complex understanding, determine new relationships between various things, find new systems and solutions to problems (Ndiung et al., 2021; Runisah et al., 2017), so that with the ability to design a project, you can produce

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innovative products. However, in doing all this, there needs to be interest or interest in carrying out these activities, both students and teachers. The greater the interest of students and the more work and drive a person has to succeed in the world of entrepreneurship. In this case, learning objectives that need to be improved include students' creative thinking skills and entrepreneurial interest.

Based on preliminary research conducted at SMAN 1 Meulaboh by interviewing chemistry teachers, the application of chemistry material has not been fully implemented in WU subjects. Entrepreneurship in schools, especially those taught by chemistry teachers, still has not produced crafts that link or utilize the chemical knowledge therein. Students still produce crafts such as making handicrafts in the form of wall decorations, recycling used goods, and so on. So far, WU learning has not implemented innovative learning models, so the learning objectives have not been fully achieved. This subject should be able to provide students with an insight into the importance of entrepreneurship. This is based on the latest trend, where the number of competent workers does not match the level of job prospects. WU subjects are expected to foster an interest in entrepreneurship in students who will continue to develop, foster a mindset that is persistent, independent, self-confident and imaginative about local and community potential. This can lead to the creation of new jobs and the prospect of the rise of an entrepreneurial generation.

There are several chemistry lesson materials that can be applied in an entrepreneurial project, including Lipid material. Through lipid materials, products related to everyday life can be produced, namely soap. However, so far no soap making project has been carried out at the school. Soap is a crucial need to support a clean and healthy life (Nurcahya et al., 2021). Since the Covid-19 pandemic, washing hands with soap has been highly recommended as the main way to control the spread of infection in the community and health facilities (Chirani et al., 2021). Soap with added herbs can also cure various skin diseases. One of them is kefir milk, which can be added to soap which is beneficial for skin health (Meri et al., 2021). Therefore, to achieve learning objectives, a learning model is needed that can help teachers and students understand the subject matter better.

Choosing the right learning model is one tactic that can be used. Learning models related to developing creative thinking skills and increasing students' interest in entrepreneurship include project based learning (PjBL) (Pujiati T M et al., 2024). The PjBL model is a type of learning that can help students become more creative in understanding material combined with real situations (Abidin, 2014). Students must work in groups to complete a project that is relevant to everyday life to use the PjBL paradigm. Students' creative ideas are demonstrated when they complete assignments, which also helps them gain the confidence they need to produce original work (Zakiah et al., 2020). PjBL goes beyond content knowledge to improve students' psychomotor and social skills. This is highly recommended for lifelong learning because it fosters critical thinking, problem solving, self-evaluation, gathering information from various sources, summarizing, and presenting (Afriana et al., 2016; Aldabbus, 2018; Rizkamariana et al., 2018). In the first stage of PjBL, teachers must be able to make maximum use of school facilities and infrastructure. One way is to use the school's internet connection to look for references for existing business ideas and prospects and arouse student interest and creativity.

The PjBL learning model may have been widely researched, but its application must be further developed in the 21st century. It is also known that through the PjBL model, students can provide opinions by thinking flexibly and originally and produce different thoughts in solving problems (Mursid et al., 2021; Nasiruddin et al., 2023; Rosaria et al., 2023). Lestari et al. (2018) research results state that students' interest in entrepreneurship can be increased through the PjBL model. By implementing PjBL, students are better able to complete projects for making simple pyrolysis and distillation equipment in chemistry learning (Nani et al., 2015). As a result, PjBL teaching helps students develop their capacity for creative thinking and their desire to start their own business. In this regard, it is necessary to carry out research that applies the PjBL model, especially in WU learning on soap making projects. It is hoped that using this learning model can increase students' interest in entrepreneurship and capacity for innovative thinking. In connection with the problems mentioned above, the researcher will conduct research with the title "Application of the PjBL Model in Entrepreneurship Lessons to Improve Students' Creative Thinking Skills and Entrepreneurial Interest at SMAN 1 Meulaboh".

Method

To find out how the PjBL model influences students' creative thinking capacity and entrepreneurial interest, this research focuses on the application of the paradigm in an experimental classroom setting. The research approach used is Pre-experimental which consists of an experimental class without any control treatment. This method was designed with a one group pretest-posttest design. The research design can be seen in Table 1.

Table 1. One Group Pretest-Posttest Research Design (Afriana et al., 2016)

Subject	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2

Information:
O1 = Pretest in the experimental class
O2 = Posttest in the experimental class
X = Learning with the PjBL model

Researchers chose one type of non-probability sampling, namely using the purposive sampling method. The use of purposive sampling is carried out for certain reasons or purposes. The selection of sample criteria is determined initially because purposive sampling is the basis for selecting the sample. Scientists chose classes XII MIPA 3 and XII MIPA 4. To get the data needed, there are several ways you can do it : Preparation stage: Researchers create research instruments and carry out trials to determine the quality of the instruments created; Implementation stage: the researcher gave a pretest to determine students' creative thinking skills and entrepreneurial interests, then treated research respondents, namely by applying the PjBL learning model, then gave a posttest and questionnaire to obtain data on students' creative thinking skills and entrepreneurial interests after given treatment; Conclusion stage: researchers analyzed students' creative thinking skills and entrepreneurial interests using Microsoft Excel and SPSS version 20.0.

Data Analysis of Creative Thinking Skills

CBC data is assessed using a scoring rubric based on CBC indicators, then analyzed using descriptive statistics. It can be calculated using the following percentage formula:

$$\text{Mark} = \frac{Student\ Answer\ Score}{Maximum\ Score} \times 100 \quad (1)$$

Table 2. KBK Percentage Criteria (Kemendikbud, 2015)

Interval	Category
94 – 100	Very good
88 – 93	Good
82 – 87	Enough
< 81	Not enough

N-Gain Data Analysis

To calculate the increase in the average score for both pretest and posttest, the normalized homogeneous gain formula is used. This formula involves comparing the actual homogeneous-average Gain to the maximum homogeneous-average Gain. The actual homogeneous gain shows the difference between the posttest and pretest homogeneous scores. The normalized Gain formula was previously called the g-factor, or Hake factor. This is calculated using the N-gain score which was created to measure concept mastery before and after Meltzer (2002) learning, namely:

$$\text{N-gain} = \frac{SPosttest - SPretest}{Smaks - SPretest} \quad (2)$$

Information:
Sposttest = Score posttest
Spretest = Score pretest
Smaks = Maximum score

Tabel 3. N-gain Value Criteria (Meltzer, 2002)

Limitation	Criteria
$g \geq 0.70$	Tall
$0.30 \leq g \leq 0.70$	Currently
$g \leq 0.30$	Low

Analysis of Students' Entrepreneurial Interests

Azwar's (2010) steps are used to calculate scores and categories of student learning interest. Table 4 shows the information obtained based on these steps.

Table 4. Categories of Students' Entrepreneurial Interests (Azwar, 2010)

Score Range	Criteria
90-120	Tall
61-89	Currently
30-60	Low

There are three levels of student entrepreneurial interest: high, medium, and low. Through the category of students' entrepreneurial interest scale towards entrepreneurship. Next, interest analysis is carried out using statistical test procedures based on scores before and after learning as follows:

$$P = \frac{f}{N} \times 100 \quad (3)$$

Information:
P = Percentage figure
f = Number of frequencies
N = Total number of samples

Result and Discussion

Students' Creative Thinking Skills

After the learning process is complete, it continues with the final test or posttest. Posttest scores for students' creative thinking skills are obtained based on answers to test questions given after the learning process by applying the PjBL model. Figure 1 below provides a summary of the results of complete data analysis regarding students' creative thinking abilities. Full results are available in the Appendix.

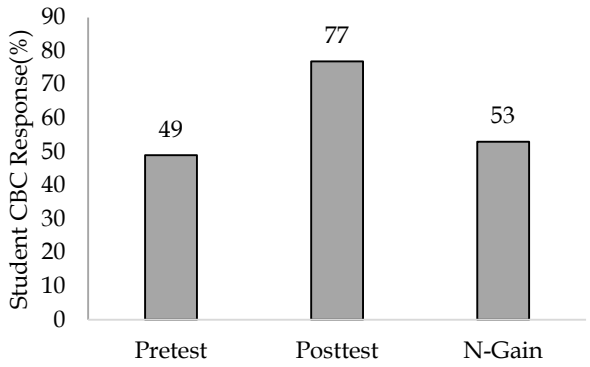

Figure 1. Average score and n-gain of students' creative thinking skills (KBK)

The KBK results of students in Figure 1 show that there are differences in KBK scores before and after treatment using the PjBL model. The N-Gain test results also show that the criteria are in the medium category, namely 53 or 0.53. Therefore, it is assumed that there is an increase in the average KBK score of students before implementing the PjBL model and after implementing the PjBL model. Based on these values, it can be interpreted that the PjBL model can increase students' capacity for original thinking. This is in accordance with previous research conducted by Kristen (2017). She claims that using the PjBL paradigm can help students become more proficient in using their creative thinking. Students' capacity for original thinking. Each indicator of creative thinking talent is studied in more detail, and the analysis findings are presented in the Appendix, a summary of which is presented in Figure 2.

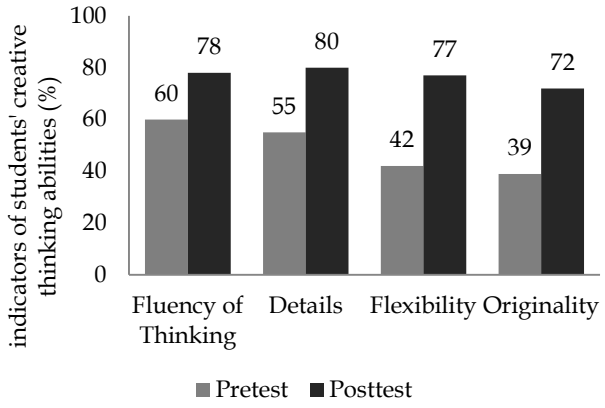

Figure 2. Analysis of creative thinking skills indicators

Data on students' creative thinking abilities for each indicator (fluency, detail, flexibility and originality) was processed using Ms. Excel software. Figure 2 shows the analysis of creative thinking skills for each indicator which has increased significantly compared to before treatment. The highest increase in creative thinking abilities is found in the detail (elaboration) indicator. These results are consistent with previous research which shows that elaboration indicators have increased after being given PjBL-based learning (Sumarni et al., 2016). Increasing creative thinking skills in the elaboration indicator shows that students are able to develop an idea or ideas in detail and students have various alternative answers related to problems.

To prove whether the proposed alternative hypothesis is accepted or rejected, the t-test is then used, namely Paired sample t-test with the help of SPSS version 20, aimed at measuring whether there is a significant increase between the average creative thinking score using the PjBL model before and after treatment. The appendix displays the results of the data analysis. A summary is presented in Table 5.

Table 5. Results of Student CBC Hypothesis Testing

Class	shapiro-wilk*	t-test sig. (2-tailed)**
Experiment	Sig: 0.02	0.00

Information:
*) : Shapiro wilk test (normal, Sig>0.05)
**) : Paired sample t-test, (significant, sig. < 0.05)

Table 5 t test results Paired sample t-test, if the value is sig. (2-tailed) <0.05, then there is a significant difference between the CBC before treatment and the CBC after implementing the PjBl model. Based on Table 5, the value obtained is sig.(2-tailed) 0.000<0.05. Thus, it can be said that before and after the PjBL model was implemented, students' creative thinking abilities increased significantly. The application of the Project Based Learning model shows learning that uses projects as a medium for students to build concepts. In implementing the project, students have the opportunity to carry out exploration, assessment, interpretation, synthesis and information to produce various forms of findings related to concepts that have been previously agreed upon with their teacher. This means that students first encounter problems as a first step in collecting and integrating new knowledge based on their experience in real activities.

From its implementation, students in the class carry out problem solving activities by applying the skills of researching, analyzing, creating, and even presenting results based on real experience. Students work independently or in groups to construct concepts which are then discussed in class. With these complex activities carried out by students, students can learn to develop and organize concepts based on their creativity, students' self-confidence, and foster students' creative souls. The essence of implementing projects in experimental classes is collaborative, so that it can be seen that groups of students are finally getting used to planning, developing concepts, managing various

sources, being active and critical in searching for information, and being creative in solving problems collaboratively with various ideas in the group. Indirectly, this means that experimental class students also practice to develop communication skills and provide experience in making time allocations to complete assignments. Of course, learning will be more enjoyable for students and student-centered, because students are the ones who plan and discover concepts in their written work as a result of student group projects which are then presented.

From the research data, the results obtained show that the average test of students' creative thinking skills before and after implementing the Project Based Learning learning model has a significant effect as shown in Table 5. The influence of increasing creative thinking skills occurs because the PjBL model can facilitate students in training their creative thinking skills by giving systematic project assignments. According to Elisabet et al. (2019) that the PjBL learning model is an innovation in learning that can be used, because PjBL aims to train students in thinking critically, creatively and rationally, actively collaborating and communicating and being real to students.

Apart from that, according to Wahyuni et al. (2019) in their research that an educator understands the material being taught so that he can develop students' thinking abilities and understand various learning models that can stimulate students' ability to learn with careful teaching planning by the teacher.

Figure 3. Results of the experimental class soap making project

Applying the PjBL model, students are involved in analyzing problems, then carrying out exploration, collecting information, interpreting and assessing projects related to the problems being studied. This allows students to develop their creativity in designing and creating projects that can be used to solve problems. In line with the research carried out, apart from students being directed to analyze a problem, students are also directed to complete a project, namely students are able to make soap as shown in Figure 3.

The syntax of the PjBL model contained in the LKPD is also able to improve students' creative thinking skills. Where teachers and students together determine what project will be carried out, starting from the process of planning the project steps to be carried out, preparing a project implementation schedule, completing the project with teacher facilitation and monitoring, preparing reports and presentations or publishing project results and evaluations project process and results. In this case, the results of project planning by students can be shown in the following figure 4.

Figure 4. Experimental class soap making project planning

Increasing students' creative thinking skills is due to the syntax of the PjBL model. where teachers and students together determine what project will be carried out, starting from the process of planning the project steps to be carried out, preparing a project implementation schedule, completing the project with teacher facilitation and monitoring, preparing reports and presentations or publishing project results and

evaluations project process and results. Improving creative thinking skills is supported by the learning process carried out using PjBL steps (Zhang et al., 2023). The first step, students in groups prepare the project instruments to be studied. This supports students' creative thinking skills in developing more detailed ideas. Supported by the theory of Sari et al. (2018) in their research, it is stated that students are required to be skilled in putting forward ideas and businesses to have new creative powers so that they can gain an increase in developing their creative thinking.

The second step in the PjBL model is that there is a plan for implementing the project to be implemented. Starting with designing the steps for completing the project and preparing the project schedule to be implemented (arranging when the project will be implemented, compiling various sources that will be used as references during implementation). This activity supports and trains students' creative thinking skills in the aspects of fluency, flexibility and originality. In line with the results of research conducted by Nita et al. (2021) which states that the activities in the PjBL steps support and train students' creative thinking skills in the aspects of fluency, flexibility and originality.

The third step is the completion of the project with teacher facilities and monitoring. This activity supports and trains students' creative thinking skills in the aspects of fluency, flexibility and originality. The next step in the PjBL model is presentation/publication of project results. In this step students can practice their communication skills and there may be suggestions from students or from the teacher. At this stage it is also possible for students to develop existing ideas or concepts (elaboration). Supported by Wahyuni's theory (2021), students will develop ideas in detail so that they can practice creative thinking elaboration. Meanwhile, the final step in the PjBL syntax is evaluating activities/experiences. In this step, teachers and students reflect on project activities and results.

Students' Entrepreneurial Interests

Alma (2019) created a questionnaire with markers of courage to take risks, creativity, independence, and future orientation which was used as a tool to measure students' enthusiasm for entrepreneurship. Students were given questionnaires before and after treatment. Figure 5 shows the percentage of students' average interest in entrepreneurship.

Based on the diagram above, the total average score for students' interest in entrepreneurship before the treatment was 61, and after the treatment it was 76. After knowing the initial value of interest in entrepreneurship, it was still relatively low. After the students were given treatment by implementing the PjBL model, they experienced an increase. This indicates the influence of the PjBL model after implementing PjBL. This is also in line with research. According to Prastyaningtyas et al. (2021), PjBL-based implementation helps students understand the virtues and benefits of entrepreneurship, including the process of generating company concepts. The average score before and after treatment increased to the medium category, this can be seen from the N-gain value, which is 36.21 or 0.36 and is included in the medium category. To be clearer, the Appendix shown in Figure 6 contains the average score of indicators of students' entrepreneurial interest.

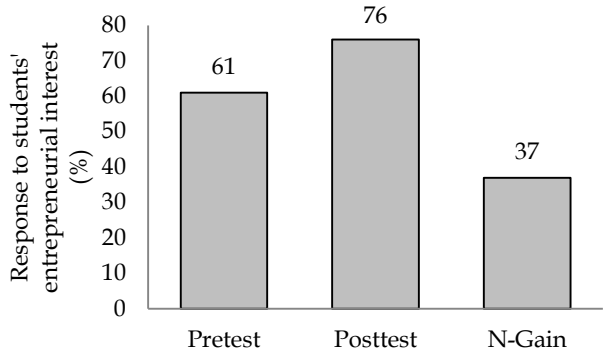

Figure 5. Results of analysis of average scores and n-gain of students' entrepreneurial interest

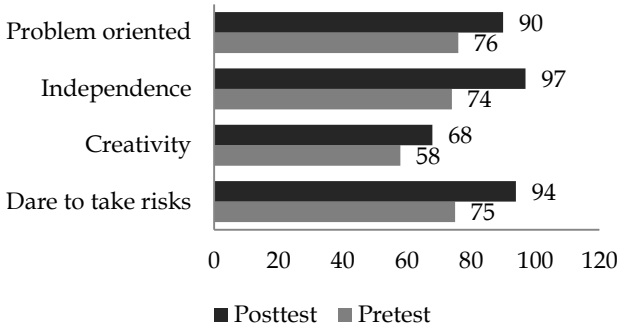

Figure 6. Analysis of entrepreneurial interest indicators

Based on the graphic data in Figure 6, it shows that every indicator of entrepreneurial spirit after implementing PjBL has increased. Based on the student's answer questionnaire after learning, they showed the courage to take risks before treatment 75 (medium) after treatment with PjBL mode 94 (high), creativity before treatment 58 (low) after treatment 68 (medium), independence before treatment 74 (medium) after treatment 97 (high) and future oriented indicators before treatment 76 (medium) after treatment 90 (high). Then a paired sample t-test was carried out. This was done to see whether the assessment of entrepreneurial curiosity before and after the learning process was significantly different from Project Based Learning (PjBL). Based on

the results of the hypothesis test data analysis, it is in the Appendix, and is briefly described in Table 6.

Table 6. Hypothesis Test Results for Students' Entrepreneurial Interest

Class	shapiro-wilk*	t-test sig. (2-tailed)**
Experiment	Sig: 0.02	0.00

Information:
*) : Shapiro wilk test (normal, Sig>0.05)
**) : Paired sample t-test, (significant, sig. < 0.05)

Based on the results of hypothesis testing, the pretest and posttest data from the students' entrepreneurial interest questionnaire using the PjBL model had a significant effect, this can be seen in Table 6, which shows the results of testing students' final scores in sig (2-tailed) with (0.000) < (0 .05) then Ha is accepted so it can be concluded that there is a significant change between before and after treatment which shows an increase in students' interest in entrepreneurship. Students realize that the activities carried out are part of learning entrepreneurial attitudes so that through implementing PJBL they can increase students' interest in entrepreneurship. This is in accordance with the opinion of Kolodner (2002), that project-based learning provides opportunities for students to work collaboratively, think critically, and explore creative ideas so as to foster students' interest in entrepreneurship. So it can be concluded that by involving students in projects that are relevant to everyday life, students' interest can increase.

PJBL activities are able to provide great opportunities to be active, creative, innovative through efforts to think critically, respect each other, and work together as social beings (Sundari et al., 2023). This opportunity contributes to increasing interest in entrepreneurship through learning, because PJBL in learning requires the teacher's ability to formulate problems related to efforts to increase interest in entrepreneurship through learning. In line with the results of research conducted during the learning process, the emphasis of learning lies on students' activities to produce products by applying the skills of researching, analyzing, creating, and even presenting learning products based on real experience.

In line with the research results of Oku et al. (2004), Project Based Learning focuses on the main (central) concepts and principles of a discipline, involving students in problem solving activities and other meaningful tasks, providing opportunities for students to work collaboratively. autonomously construct their own learning, and the culmination produces valuable and realistic student work products. So the PjBL model influences students' interest in entrepreneurship.

Conclusion

In general, the aim of this research is to see the effect of implementing the PjBL model in Entrepreneurship lessons on students' creative thinking skills and entrepreneurial interest at SMAN 1 Meulaboh. The findings show that there is a positive influence on students' creative thinking skills and entrepreneurial interest. The results of the t test analysis show a significant value greater than 0.05, which means that the PjBL model has a significant effect on students' KBK and entrepreneurial interest.

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Author Contributions
Conceptualization; M.A., M. A., I. K., S. W., M., H.: methodology; M.A., validation; M. A.: formal analysis; I. K.: investigation; S. W.; resources; M., H: data curation: M.A.: writing—original; M. A: draft preparation; I. K: writing—review and editing: S. W; visualization: M., H. All authors have read and 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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