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The Effect of Process Oriented Guided Inquiry Learning (POGIL) Integrated Flipped Classroom on Problem Solving Ability and Self-Efficacy of High School Students on Thermochemistry Material

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Abstract: This research aims to determine problem solving ability and self-efficacy simultaneously and respectively of students instructed using Process Oriented Guided Inquiry Learning (POGIL) integrated flipped classroom and the effective contribution. This research is a quasi-experiment with posttest only control group design. The population in this study includes all students of class XI MIPA in senior high school in Mandau Subdistrict. The research samples were taken using cluster random sampling. The research was carried out at SMAN 2 Mandau. The research instruments are essay questions of problem-solving ability and self-efficacy questionnaires. The data analysis used the MANOVA test with Hotteling's Trace test. The result of the research showed that there are significant differences in problem solving ability and self-efficacy simultaneously and respectively of students instructed using Process Oriented Guided Inquiry Learning (POGIL) integrated flipped classroom with a scientific approach on thermochemistry material and the effective contribution toward problem solving ability and self-efficacy simultaneously on thermochemistry material is 11.50%, problem solving ability 11.30% and self-efficacy 4.80%.

Keywords: Flipped classroom; POGIL; Problem solving ability; Self-efficacy; Thermochemistry

Introduction

Education is an important effort to create the nation's generation to compete in the 21st century. In order to succeed in education in the 21st century, students have to develop a variety of skills (Jayadi et al., 2020). However, until now there are still various obstacles in Indonesia's educational system that have an impact on the country's low educational standards (Nurhuda, 2022). According to Tohir (2019), PISA (Programme for International Student Assessment) study results in 2018 placed Indonesia in the bottom 10. This shows that the condition of education in Indonesian is still relatively low that improving the education is essential to developing 21st century learning competencies.

Problem-solving ability is one of the fundamental 21st century skills that is essential for success in life (Rahman, 2019). Problem-solving ability is the ability to recognize problems and choose the right way for resolving problems (Singaravelu, 2017). Problem-solving ability involves a number of cognitive processes in searching for answers (Ardhana, 2020). Irwanto et al. (2018) explained that students' skills will improve if they engage in problem solving and succeed in finding solutions. These skills can support decision making and

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enable facing problems from different perspectives. However, the ability of students to solve problems is still low (Rohayah, 2022). Students tend to be passive, have difficulty in explaining concepts and have difficulty solving problems that require reasoning and analysis skills (Irwanto et al., 2017). Students can solve simpler problems, but lack the ability to solve complicated and complex quantitative problems (Rohayah, 2022).

Teachers have a big role because teachers are at the forefront of organizing education (Barokah et al., 2021). Students' thinking skills should be facilitated by the design of the learning process (Hafizah & An'nur, 2018). The fact is that students have difficulty in solving problems that require reasoning and analysis skills because the knowledge acquired by students is limited so that it does not foster independence and interest in learning (Irwanto et al., 2017). The lack of teacher strategy innovation is a problem in learning (Gawise et al., 2023). Students become less trained in solving problems due to the lack of teacher innovation in implementing learning models or strategies.

One of the main principles of success of the current learning processes is that students build their own knowledge through the thinking process, not what is taught by the teacher (Hafizah & An'nur, 2018). Active learning can have an impact on improving student learning outcomes (Aji & Khan, 2019). Meaningful learning promotes learner-centered learning. But in reality, the problem that often arises during the field is that teachers often apply conventional teaching methods (Aidoo et al., 2022). This was also stated by Istuningsih et al. (2018) that learning is teacher-centered because most teachers use the lecture method.

Chemistry is one of the lessons has a high level of urgency (Rahmasari et al., 2019). Jegstad & Sinnes (2015) affirming that students must understand the importance of chemistry needed to enhance their abilities and solve problems related to chemists in the surrounding environment. However, in reality there are still many students who experience difficulties when learning chemistry. Students who are learning chemistry usually have difficulty understanding complex chemical concepts and need to apply mathematical calculations in order to solve problems (Priliyanti et al., 2021). Thermochemistry is one of the chemistry materials in class XI of senior high school. Thermochemistry is an important concept for students to understand. But in reality, students' understanding of thermochemistry materials is still low (Dewi *et al*., 2018). According to Kurnia et al. (2022), students consider thermochemistry difficult to understand because of the complex material. Although chemistry is important, most students still have low motivation to learn at school (Yuliastini et al., 2018).

The use of less interesting teaching strategies by teachers causes low motivation to learn chemistry (Salta & Koulougliotis, 2012). Rivalina & Siahaan (2020) explained that learning activities in schools are generally still dominated by teacher activities. The ineffectiveness of teacher-centered teaching results in a lack of involvement and activeness of students so that they are unable to improve understanding and higher-order thinking skills (Addae & Quan-Baffour, 2018). This causes students to find it difficult to apply the knowledge they have learned in solving specific problems (Olaniyan et al., 2015). Chemistry learning that is carried out generally uses a scientific approach that makes students less actively involved in the learning process in school. Therefore, as professional education personnel, teachers are required to be able to apply models, strategies or learning methods that can improve the problem-solving ability of students.

Innovative learning strategies and models can be used in an effort to foster problem-solving skills. Students' ways of thinking can be facilitated and developed through innovative learning (Hafizah & An'nur, 2018). Problem-solving skills can be improved by implementing inquiry learning because it provides opportunities for students to create their own knowledge and develop it (Fitriana et al., 2019). One inquiry-based learning strategy to help improve problem-solving skills is POGIL (Process Oriented Guided Inquiry Learning) learning strategy. POGIL is learning that focuses on learner-centered processes by applying the learning cycle in guided inquiry activities (Malik et al., 2017). Students use guided inquiry on exercises in learning groups through POGIL learning design (Hafizah & An'nur, 2018). The stages of POGIL learning are orientation, exploration, concept formation, application, and closure, which are carried out by students in small groups (Hanson, 2005).

The advantages of POGIL compared to other inquiry-based methods are the guided level is focused on the process of obtaining concepts, is more constructive and interesting and allows each learner to have their own role in concept discovery (Irwanto et al., 2018). Various studies have shown that POGIL has a positive impact on learning (e.g., Chase et al., 2013; Irwanto et al., 2018; Rustam et al., 2017; Sanggara et al., 2018). According to Irwanto et al. (2018), the improvement of students' problem-solving ability shows that POGIL is an effective strategy in improving student performance.

Learning in accordance with 21st century learning is not only limited to the application of learning strategies. After the COVID-19 pandemic, Indonesia is in the process of recovery in the field of education. The pandemic has caused Indonesian children to experience

"Learning Loss", which is a condition of declining academic skills or knowledge of children due to lack of interaction between teachers and students directly in the process of transferring information (Rejeki, 2022). This global pandemic requires educators to utilize technological innovations in learning. It paves the way for educators to apply appropriate methods that will actively engage students to learn and acquire 21st century skills. Flipped classroom is an alternative solution in integrating technology into the learning process. Integrating technology into flipped classroom learning process can overcome time constraints in the classroom and students' problem-solving skills can be improved (Syakdiyah et al., 2018).

The integration of flipped classroom in POGIL learning strategy is expected to overcome problems of learning loss so that students' problem-solving ability can improve. In flipped classroom, the teacher's direction in the classroom is transferred to outside the classroom, students are assigned to understand the material from home through learning videos. The integration flipped classroom in POGIL learning uses learning time outside the classroom by watching learning videos that are adjusted to the stages of POGIL learning. This is supported by current learners who already use technology in everyday life such as smartphones so it would be beneficial if these technologies were integrated in learning to improve the quality of learning. POGIL learning integrated with flipped classroom is expected not only to improve the cognitive aspect of students' problem-solving abilities, but also to have a positive impact on affective aspects or attitude, namely self-efficacy. Students with this attitude are confident in their ability to complete assignments, solve problems and take part in class activities in order to get the expected results (Peranginangin et al., 2019).

Self-confidence is one of the components in the affective domain with terms self-efficacy. Low self-confidence will make students less confident in asking questions and solving problems, thus hampering their ability to learn. This is in accordance with the findings Jatisunda, (2017) that problem-solving ability is related to students' self-efficacy of students because it has a significant impact on the successful completion of students' tasks. However, according to Peranginangin et al. (2019), when teachers ask students to present their answers in front of the class, they become frightened and they are less challenged to solve complex problems. This indicates that students' self-efficacy is low and has to be increased because high self-efficacy will give a high level of motivation to learn.

Based on the results of the study AlJaser (2017), the use of flipped classroom can increase students' self-efficacy. Vishnumolakala et al. (2017) explained that POGIL learning also has a positive effect on students' confidence levels in understanding chemistry content and applying the knowledge gained. This shows that in addition to cognitive aspects, POGIL learning integrated flipped classroom can also affect the affective aspects of students' self-efficacy. According to constructivist learning theory, inquiry-based learning and flipped learning are two effective learning approaches that support students' construction of new knowledge (Aidoo et al., 2022). According to research by DeMatteo (2019) which combines POGIL with flipped classroom in organic chemistry, there is a significant difference in student achievement, and is able to maximize the interaction between students and teachers. Therefore, efforts in developing students' problem-solving abilities and self-efficacy in chemistry learning need to be done, especially on thermochemistry materials.

However, previous research shows that POGIL integrated with flipped classroom has not yet been applied for problem solving ability and self-efficacy in high school students. Furthermore, there are very few researchers who report their findings in chemistry learning (DeMatteo, 2019; Syafei & Mawardi, 2022). Although previous research has been conducted on several chemistry materials, thermochemistry material has not been applied to POGIL integrated flipped classroom. The integration of POGIL syntax in the pre-class and in-class phases in the flipped classroom is another novelty in this study. Both variables have not been applied directly in the POGIL integrated flipped classroom in previous research. It is important for students to have both variables of problem-solving ability and self-efficacy in chemistry learning through learning strategies or methods. For this reason, the researcher's effort to improve the problem-solving ability and self-efficacy of students on thermochemistry material is to conduct this research. This research aims to determine problem solving ability and self-efficacy simultaneously and respectively of students instructed using Process Oriented Guided Inquiry Learning (POGIL) integrated Flipped Classroom and the effective contribution.

Method

This research is quasi experimental with post-test only control group design. This study used 4 classes with 2 experimental classes and 2 control classes. The experimental class applied Process Oriented Guided Inquiry Learning (POGIL) integrated flipped classroom and the control class applied a scientific approach. The dependent variables in this study are problem-solving ability and self-efficacy.

Table 1. Research Design

Class	Treatment	Post-test
Experiment	X1	PS, SE
Control	X2	PS, SE

Information:
X1 : Process Oriented Guided Inquiry Learning (POGIL) integrated flipped classroom
X2 : Scientific approach
PS : Problem solving
SE : Self-efficacy questionnaire sheet

The learning steps in experimental class using POGIL integrated flipped classroom shown in Figure 1.

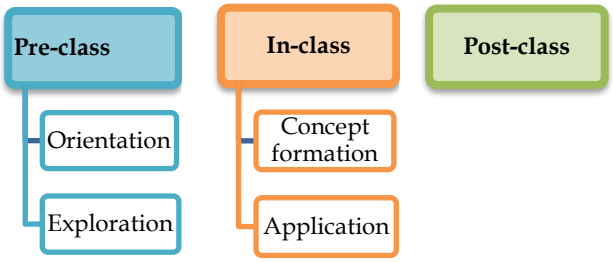

Figure 1. The learning steps POGIL integrated flipped classroom

This research was carried out at SMAN 2 Mandau. The study population was all students of class XI MIPA SMA Negeri in Mandau Subdistrict. The sampling technique was cluster random sampling of the entire classes XI Science SMAN 2 Mandau. The total sample was 134 students of class XI Science SMAN 2 Mandau. There were 2 experimental classes and 2 control classes. Test techniques from questions and non-test techniques from questionnaires are used in data collection techniques. The data collection instruments used in this study were problem-solving ability essay questions and self-efficacy questionnaire sheet. The research instruments were tested for validity and reliability. Instruments and learning devices were theoretically validated by expert judgement. Empirical validity was carried out on class XII students who have studied thermochemistry material and analyzed using the Rasch Model assisted by the Winstep program.

The data analysis technique used in this research is multivariate analysis with MANOVA (Multivariance Analysis of Variance) technique using IBM SPSS Statistics 26 and quantitative descriptive analysis technique. Before conducting the MANOVA test, assumption test must be carried out. After all MANOVA assumptions are met, the MANOVA test can be conducted. The decision criteria used are if the significance value < 0.05 then H_0 is rejected and if the significance value > 0.05 then H_0 is accepted. Effective contributions are obtained from partial eta squared.

Result and Discussion

Theoretical validity aims to determine the suitability of the content of the instrument as a whole with aspects of the variables of problem-solving ability and self-efficacy. This validity involves two chemistry education lecturers as expert judgment. The results of theoretical validity are in the form of descriptive descriptions in the form of suggestions and input to improve the instrument to be suitable for use in data collection. Empirical validity test was carried out on 67 students of class XII MIPA SMAN 2 Mandau who had studied thermochemistry. The problem-solving ability tested were 10 questions and the self-efficacy questionnaire statements were 32 statements. The results of empirical validity, there is 1 item of invalid problem-solving ability questions so that question number 10 is invalid and not used in research. The results of empirical validity of the self-efficacy questionnaire obtained 3 statement items, namely items number 6, 17, and 32 which were invalid so that 29 valid statements were obtained. The reliability results show that the problem-solving ability questions and self-efficacy questionnaire sheets are reliable and can be used in the research shown in Table 2.

Table 2. Reliability Results of Problem-Solving Skills and Self-Efficacy Questionnaires

Variable	Cronbach alpha	Person reliability	Item reliability
Problem solving ability	0.79	0.78	0.98
Self-efficacy	0.91	0.89	0.96

The post-test scores of problem-solving ability and self-efficacy questionnaires of students gave different results between the experimental class and the control class. Comparison of the average score on problem-solving ability and self-efficacy between experimental and control class can be seen in Figure 2.

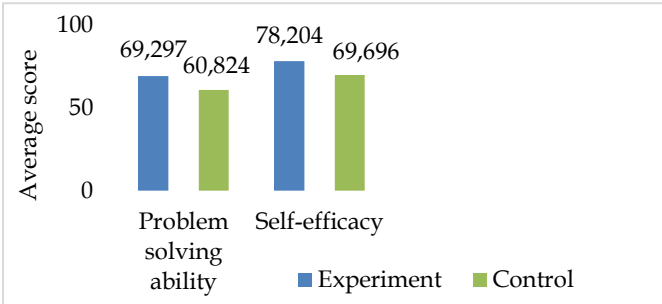

Figure 2. Comparison of average scores of problem-solving ability and self-efficacy

Figure 2 shows that the average score of problem-solving ability in the experimental class and the control class was 69.297 and 60.824 respectively. The average score of self-efficacy in the experimental class and the control class was 78.204 and 69.696 respectively. It shows that the experimental class using POGIL integrated flipped classroom has higher average score for problem-solving ability and self-efficacy than the control class using a scientific approach.

The MANOVA assumption test was conducted first before conducting the MANOVA test. The results of Box's M test show the homogeneity test of the variance-covariance matrix. Table 3 shows the results of Box's M test.

Table 3. Test Results of Box's M Matrix Variance-Covariance

Box's M	F	Df1	Df2	Sig.
1.609	0.528	3	3229269.972	0.663

Based on the results on Table 3, the sig value is 0.663 > 0.05. It means that the sample comes from a population that has the same matrix of variance. The multicollinearity test is identified by examining the tolerance value and Variance Inflating Factor (VIF). The allowed value for tolerance > 0.1 and the VIF value < 10. The results of the multicollinearity test can be seen in Table 4.

Table 4. Multicollinearity Test Results

Variable	Collinearity statistics	
	Tolerance	VIF
Problem solving ability	0.697	1.434
Self-efficacy	0.697	1.434

The tolerance value obtained is 0.697 > 0.01 and the VIF value obtained is 1.434 < 10, so it means that there is no multicollinearity. MANOVA assumptions test that have been met can be continued with MANOVA statistical tests. The MANOVA statistical test is used to determine whether or not there is a significant difference in the problem-solving ability and self-efficacy of students simultaneously and respectively who participates in learning with POGIL integrated flipped classroom by looking at Hotteling's Trace value in the MANOVA test result table. Hotteling's Trace results obtained from the multivariate test are shown in Table 5.

Table 5. Hotteling's Trace Results on Multivariate Test

Effect	Sig.	Partial eta squared
Class	0.000	0.115

The multivariate test analysis results shown in Table 5 led to the sig value obtained is 0.000. The significance value is 0.000 < 0.05, so that H_0 is rejected and Ha is accepted. Thus, it can be claimed that there are significant differences in problem-solving ability and self-efficacy simultaneously.

To determine the significant difference in problem-solving ability between students POGIL integrated flipped classroom with a scientific approach on thermochemistry material. The post hoc test results are obtained from the Test of Between Subject Effect shown in Table 6.

Table 6. Test of Between Subject Effect Results on Problem Solving Ability

Dependent variable	Sig.	Partial eta squared
Problem solving ability	0.000	0.113
Self-efficacy	0.011	0.048

Based on the results of Table 6, the significance value is 0.000 < 0.05, so that H_0 is rejected and Ha is accepted. Thus, it can be claimed that there are significant differences in problem-solving ability and self-efficacy respectively.

Differences in Problem Solving Ability and Self-Efficacy between POGIL Integrated Flipped Classroom and Scientific Approach

The experimental class using POGIL integrated flipped classroom has higher average score for problem-solving ability and self-efficacy than the control class using a scientific approach. The result showed that there are significant differences in the problem-solving ability and self-efficacy of students in experimental and control classes.

POGIL learning integrated flipped classroom is a combination of POGIL learning strategies and flipped classroom approach. POGIL is an interactive learning technique that has proven to be an effective strategy in an active and collaborative learning environment for learners (Deora et al., 2020). Flipped Classroom is a flipped learning where learners learn first generally through videos at home, and then carry out high-level learning activities in class (O'Flaherty & Phillips, 2015).

POGIL learning integrated flipped classroom is proven to provide a significant difference with control classes because learning requires learners to be active in learning. Students' knowledge construction is facilitated by the guided inquiry found in POGIL activities (DeMatteo, 2019). This research applies POGIL integrated flipped classroom where teachers prepare for pre-class learning through learning videos. In pre-class learning, students learn in advance the learning videos that have been given. The provision of this learning

video is a stage orientation in the POGIL learning step. In order to help students connect the concept to a real-life phenomenon, the orientation stage in the form of a video presents real-life phenomena linked to the lesson to be learnt. POGIL learning integrated flipped classroom can be implemented using a learning platform such as Edmodo (Hasanah et al., 2021; Syafei & Mawardi, 2022) in providing videos at the orientation stage. In this study, researchers used google classroom because it is easy to use, flexible and accessible (Salamah, 2020). Google classroom is a commonly used learning platform into lessons so students are familiar with certain aspects of the online platform (Turchi et al., 2020). Students have also been accustomed to using the classroom application. Furthermore, on the exploration stage, students are given questions or a set of assignments, as a guide for students regarding what will be done to achieve learning objectives (Hanson, 2013). The pre-class phase in google classroom can be seen in Figure 3.

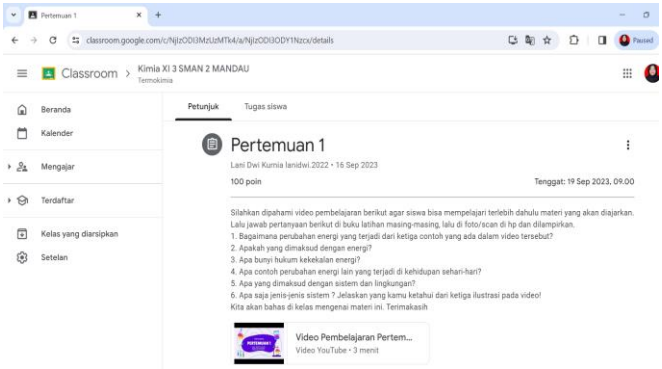

Figure 3. The pre-class phase in google classroom

The answers from students at this stage are written in note book and uploaded in google classroom. It can be seen in Figure 4.

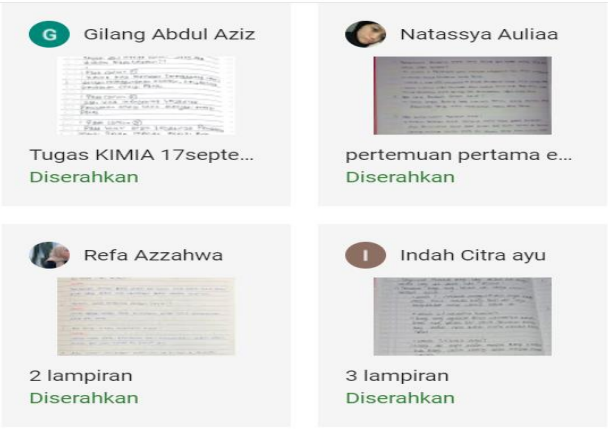

Figure 4. Students' assignments uploaded in google classroom

POGIL is learning that exposes students to critical thinking questions that help them to develop their own concepts. This is certain to generate long-term memory and lead to learning that is more meaningful learning (Purnama & Rahayu, 2023). Pre-class activities allow students to prepare ahead of time, which enables them to use investigative learning to solve problems during in class. The pre-class in experimental class places the responsibility for students to learn more while giving them greater encouragement to experiment (Danker, 2015). It supports aspects of motivation with indicators of learning independence and task orientation with indicators of accepting and completing tasks with responsibility which are aspects of self-efficacy. Things that are not understood by students are noted and can be asked in the in-class phase during face-to-face learning. This is in line with Cormier & Voisard (2018) which encourages learners to make notes and unresolved questions to ask in class.

The in-class phase is conducted face-to-face in the classroom. Teacher facilitates students who want to ask questions so that they can ask questions and provide oral questions related to video that have been given before. This certainly trains the self-efficacy aspects of students to dare to speak and have the confidence to answer and ask questions. The learning steps carried out are: concept formation, application and closure. Students in the classroom are divided into groups with 4 people in each group who have the role of manager, presenter, recorder and strategy analyst. In the concept formation step, students can find and form concepts. Each group is given a student worksheet for discuss. Student worksheet include questions that help develop the understanding problems, their ability to plan solutions and put those solutions into practice. This has an impact on POGIL so that it can help students understand concepts with a process-oriented, constructive and interactive, where each student has a role in understanding the concept (Irwanto et al., 2018).

The next step is application. This stage involves using new knowledge in exercises on student worksheet. Students are given practice questions to apply the concepts that have been formed. It can train and familiarize students in problem-solving ability. Then it ends with the closure stage. At this stage, the teacher together with students validate the results that have been achieved, reflect on what has been learned and assess the results of their performance. Validation is done by presenting the results of the discussion in front of the class to get feedback. This trains students in evaluating the results of the solution.

Based on descriptive analysis after treatment, it showed that the average score was higher in experimental classes with POGIL learning integrated

with flipped classroom so that it is provides compared with the control class using a scientific approach. This is in line with Tang et al. (2020) with a higher average scores in. The result of this research is also in line with Utari et al. (2023) which states that students can use their prior experiences and current knowledge to come up with original ideas and modify their problem solving strategies for different situations. Chase et al. (2013) reported the result that the implementation of POGIL in the discussion section had positive impacts on grades in general chemistry course. POGIL has a phase that guides students through exploration activities so that students can build their own understanding so that POGIL learning is more effective in improving student problem solving. The results also reinforce AlJaser (2017) research on flipped classroom showing that students actively participate in disseminating knowledge compared to students who receive knowledge through teaching and lecturing so that it has an influence in building problem-solving ability and self-efficacy in their personal ability to perform required tasks.

POGIL has phases that guide students through exploration activities so that students can build their own understanding (Sanggara et al., 2018). The experimental group had better score results because they built their skills by exploring problems through group discussions, discovering concepts through their experiences, applying concepts through inquiry learning (Irwanto et al., 2018). At the application stage, it also contributes to applying the concepts that have been formed to practice questions so that it affects problem solving.

Integrating flipped classroom provides more effective learning time in the classroom because students have readiness to learn through the pre-class phase while the scientific approach learns the material directly in class during learning. In line with Adhitiya (2015) explains that through pre-class, learning time in class can be carried out learning activities that apply higher thinking skills so that they can actively solve the problems given. Studenst become more interested in the learning process using flipped classroom (Novitri et al., 2022). This is reinforced by Halili & Zainuddin (2015) who states that flipped classroom will make efficient instruction and activities since students have prepared learning materials before coming to class and teacher will take on the role of facilitator to guide students' instead of teacher teaching. Discussion in class might take up valuable time rather than listening to teachers. This has a positive influence on the experimental class's students' self-efficacy so that they are more active in discussing and answering questions compared to the control class that has not had preparation before class begins.

The effective contribution given by POGIL integrated flipped classroom toward problem-solving ability and self-efficacy of students on thermochemistry material is 11.50% in the medium category. It can be concluded that the implementation of POGIL integrated flipped classroom has a positive impact on the problem-solving ability and self-efficacy of students in experimental classes. This result is consistent with DeMatteo (2019) who showed the positive effect of combining POGIL and flipped classroom comparison to traditional interactive lecture methods in organic chemistry classes.

Differences in Problem Solving Ability between POGIL Integrated Flipped Classroom and Scientific Approach

The result showed that there is a significant difference in the problem-solving ability of students in the experimental class and the control class. The difference in students' problem-solving abilities is due to the fact that in the experimental classroom they involve students actively. POGIL learning presents students to explore through the questions which then ask students to find their own concepts and apply the concepts created to new situations in the form of exercises in the student worksheet (DeMatteo, 2019). According to Dori et al. (2018), frequent learning tends to develop low-level thinking skills during class, as shown by Bloom's Taxonomy. In contrast, the experimental class using flipped classroom reverses this by giving students advance preparation, allowing them to engage with investigative learning to solve the problem during in-class. As result, higher order thinking skills like analysis and evaluation are taught in the classroom with assistance from peers and teacher direction, while lower-order thinking skills like remembering and understanding are done at the student's own speed outside of the classroom.

Each stage in POGIL integrated flipped classroom provides involvement in practicing problem solving. The pre-class phase at the orientation stage trains students in understanding the problems in the video. Students are trained to understand the problem by mentioning existing information and can ask questions related to the video. Furthermore, at the exploration stage, students are given questions. This stage trains problem-solving ability on indicators of understanding problems. The concept formation stage by asking questions on student worksheet so that according to Fitriana et al. (2019) can train students in planning solutions. Purnama & Rahayu (2023) explained that at this stage requires students to find important information and process the information obtained to form new concepts. If experiencing problems in forming concepts, students will develop strategies to solve

problems until they get the appropriate concepts. Then the application stage by applying the concepts that have been formed in the practice questions. This can be used to train indicators of problem-solving ability. They are understanding problems, planning solutions, and carrying out solutions. Then it ends with the closure stage by presenting the results of the discussion and reflecting on what has been learned and assessing the results of their performance. The teacher's only role in this stage is to facilitate the presentation and make sure everything goes well (Khairunnisak et al., 2023). This can be used to train problem solving ability on indicators of evaluating the results of solutions.

The effective contribution given by integrated POGIL flipped classroom toward problem-solving ability is 11.30% in the medium category. POGIL integrated flipped classroom proves that there is a positive influence given. These results are consistent with Hafizah & An'nur (2018) which shows that POGIL learning has an impact on problem-solving ability with medium criteria. Relevant study is Rosidah (2013), which shows that students' problem-solving ability in student worksheet assisted POGIL learning is higher than the traditional learning model on the subject matter of Class XI Opportunities. In line with the result of research by Subagiyo et al. (2023) that sudents learning achievement higher with inquiry-flipped classroom model because they must prepare for the learning practice by summaring the learning material.

Differences in Self-Efficacy between POGIL Integrated Flipped Classroom and Scientific Approach

The result showed that there is a significant difference in the problem-solving ability of students in the experimental class and the control class. Self-efficacy refers to a persons' confidence in their ability to face and solve problems in a variety of conditions as well as their ability to decide how to act when faced with particular tasks or problems (Peranginangin et al., 2019). This ability enables people to overcome obstacles and accomplished their desired outcomes. Aspects of self-efficacy based on the results of the synthesis that researchers do are motivation, task orientation, perseverance, confidence, problem solving, and performance. Here is the difference in average scores based on each aspect shown in Figure 5.

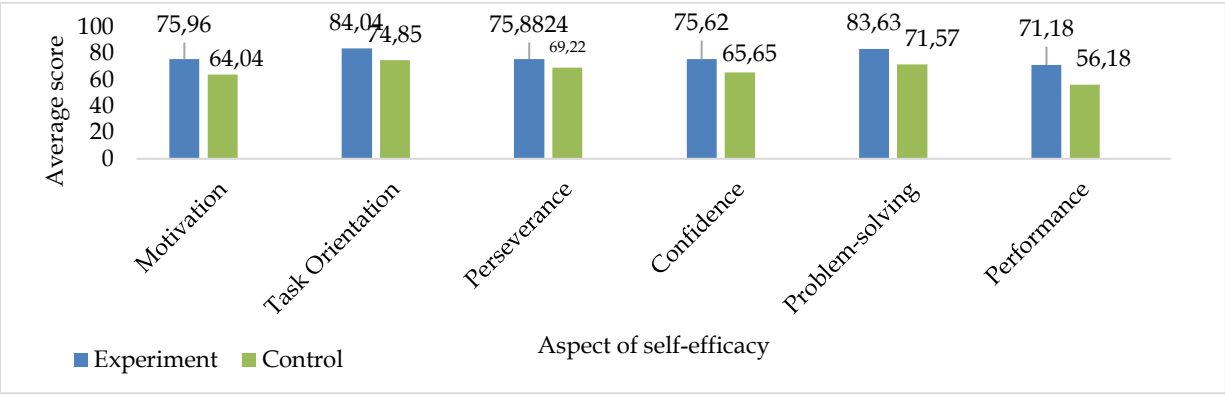

Figure 5. Graph of the average self-efficacy of each aspect

Based on Figure 5, the highest average score is in the aspect of task orientation. The indicator in this aspect is accepting and completing tasks with responsibility. This is in accordance with Danker (2015) who explains that flipped classroom provide students more responsibility for learning while also encouraging them to try new things.

Based on the research conducted, at the beginning of the meeting, there were still students who were not active in answering questions due to students who did not understand the video. Then, researcher encouraged students to be confident in answering questions and ask students to prepare by watching videos and answering questions first before class. The next meeting, students have begun to have the courage and confidence to answer oral questions from researcher about the video that have been studied. Students have also begun to ask questions related to things that have not been understood from the pre-class activities carried out. This began to increase until the fifth meeting where students had done pre-class assignments even though there were still some students who did not watch and do pre-class assignments, but in general during class they could be more active in class. Students feel that by solving a problem through a video that teacher provides, students' curiosity gets excited and they are able to concentrate on working on learning activities in class (Putri et al., 2022).

Flipped classroom applied in the experimental class helped students actively participate in spreading knowledge, unlike those who receive knowledge in the control class. Flipped classroom had an affect on self-

confidence in their personal ability to perform the required tasks (AlJaser, 2017). Discussion activities carried out in POGIL learning integrated flipped classroom make students more active and courageous in discussions to solve problems because they already have readiness in the phase in-class. The implementation of POGIL integrated flipped classroom is proven to show significant differences compared to the scientific approaches. These results are also consistent with the study of Nur DS et al. (2023) that the self-efficacy of students who use the flipped classroom learning is higher than students who do not use flipped classroom with a significant difference. The result of Lai & Hwang (2016) which states that the experimental class' self-organization performance was better than the control group. This finding is also reinforced by Hamdan et al. (2013) that flipped classroom will increase students' motivation and confidence in the classroom because with pre-class, they have been ready for their learning when they are outside of the classroom. Compared to the control class that applied a scientific approach, learning took place during class, and students had not learned the material before, so students were less confident in answering questions and discussing in class because they still needed more time to understand the material taught.

The effective contribution given in POGIL learning integrated flipped classroom on self-efficacy is 4.80% with a small category. This can be caused by the research time is quite short and limited in carrying out the research. The limited research time given for 1 subject matter is one of the causes of the low effective contribution obtained. Learning becomes less optimal so that the students' self-efficacy variables cannot change drastically in a short period of time. Another reason may be that there are still some students who do not do pre-class assignments which affect self-efficacy when learning takes place. Students who have not watched the video cause less confidence in answering questions because they do not have provisions before. These findings are in line with Halili & Zainuddin (2015) that when teachers are enthusiastic in applying flipped classroom, not all students want to watch videos of pre-class because the students are not ready for the changes that occur. Nevertheless, most of the students have done POGIL learning integrated flipped classroom in this study so that POGIL learning integrated flipped classroom still has an influence on students' self-efficacy.

Conclusion

Based on the results and discussion that has been described, it is concluded that there are significant differences in problem solving ability and self-efficacy simultaneously and respectively between students who follow Process Oriented Guided Inquiry Learning (POGIL) integrated flipped classroom with a scientific approach on thermochemistry material, the effective contribution from Process Oriented Guided Inquiry Learning (POGIL) integrated flipped classroom on problem solving ability and self-efficacy simultaneously on thermochemistry material is 11.50% in medium category, effective contribution toward problem solving ability on thermochemistry material is 11.30% in medium category and effective contribution toward self-efficacy on thermochemistry material is 4.80% in small category.

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The authors declare no conflict of interest.

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