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“Project Based Learning (PBL) to improve Psychomotoric Skills : A Classroom Action Research”,

PENGUSUL
Dr. Woro Sumarni, M. Si / NIDN 0023076507

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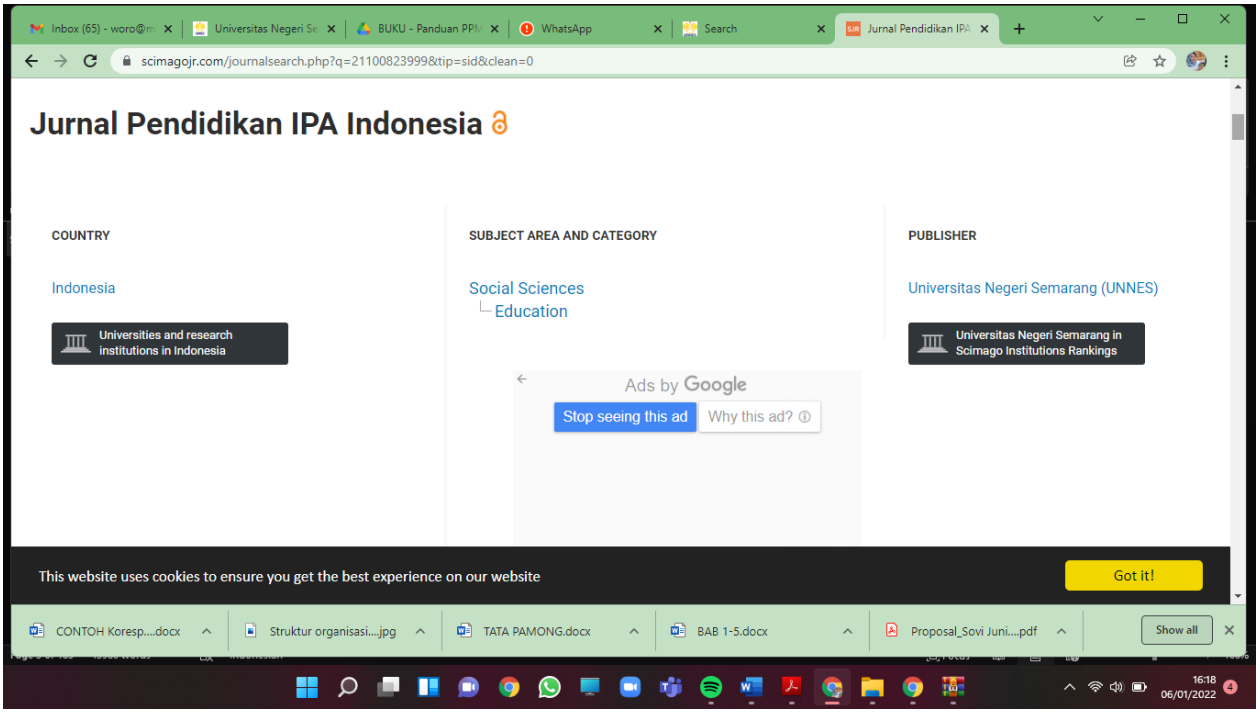

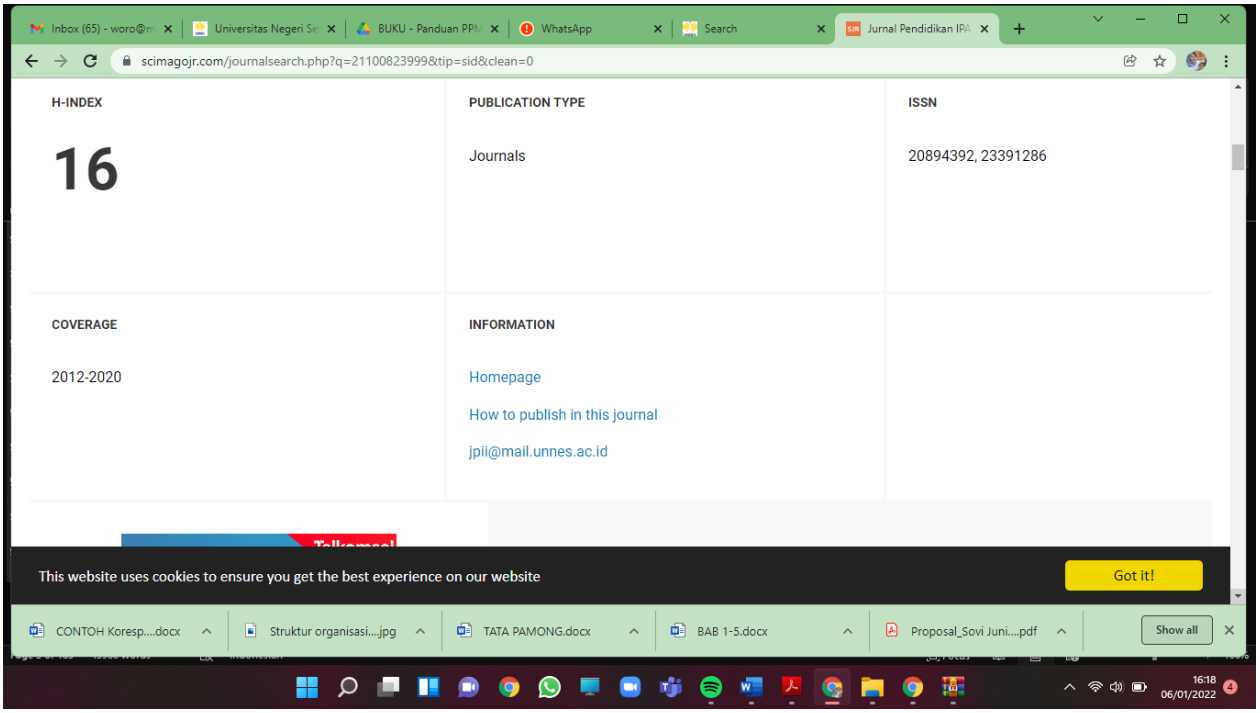
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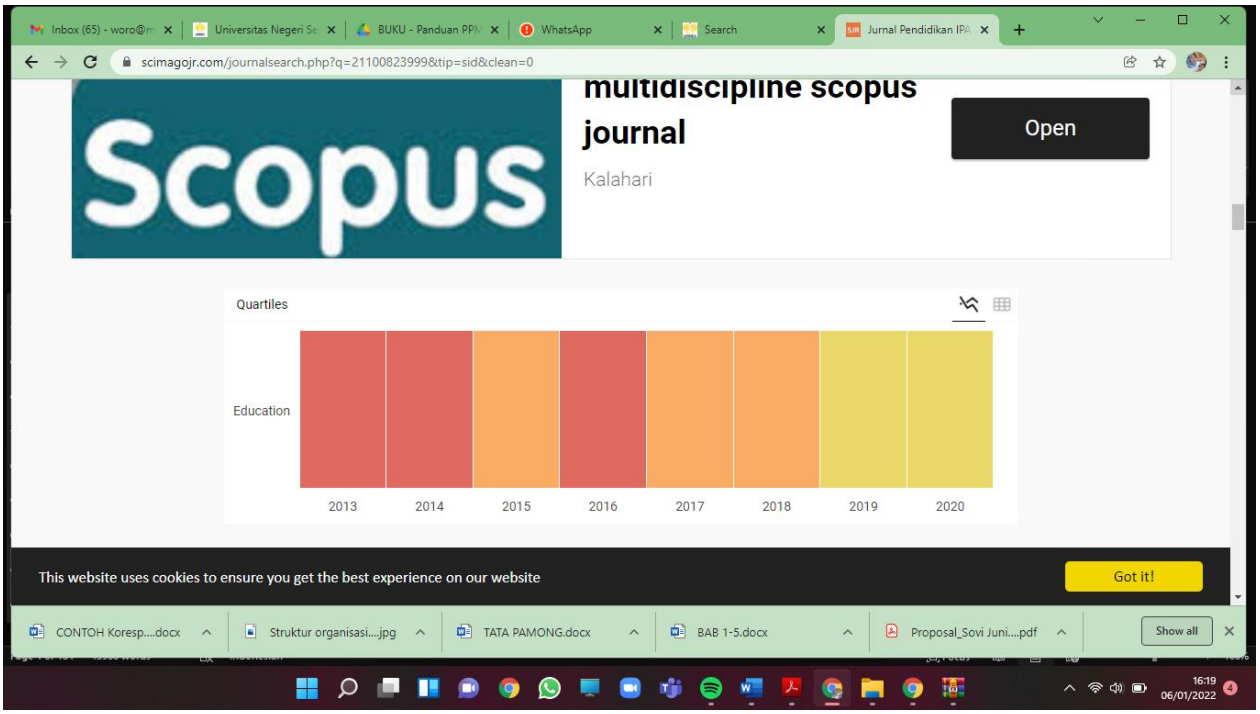
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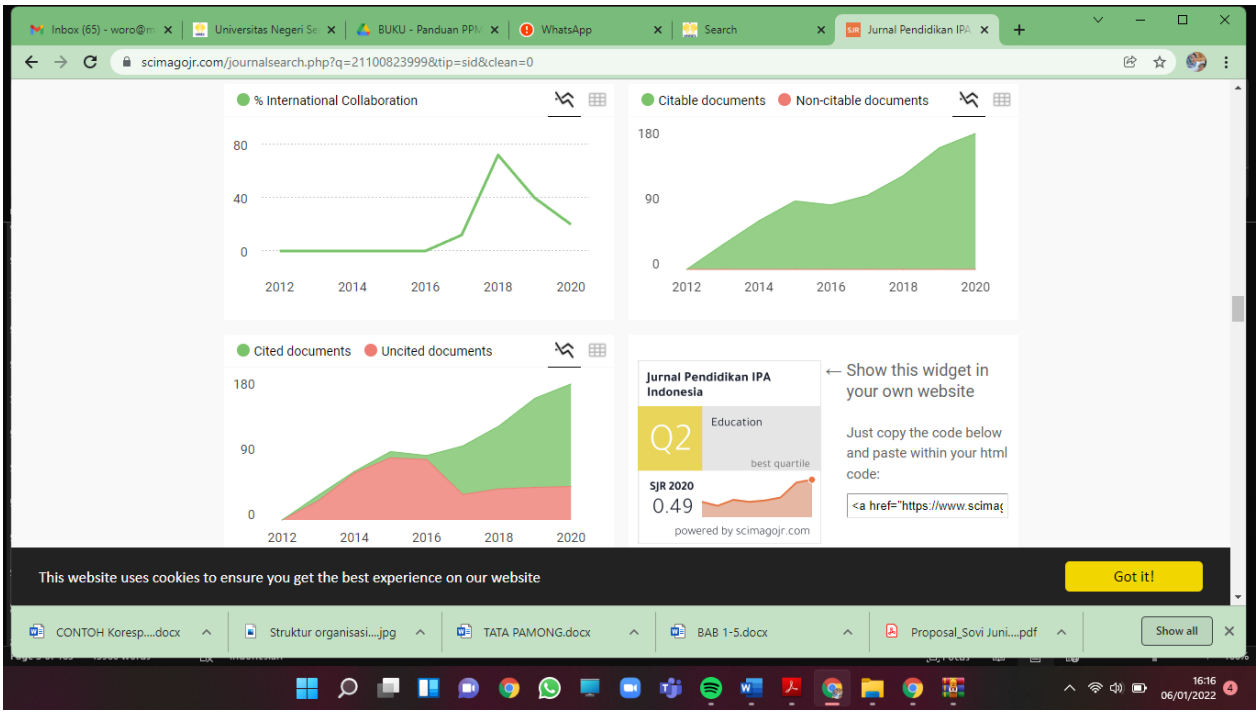
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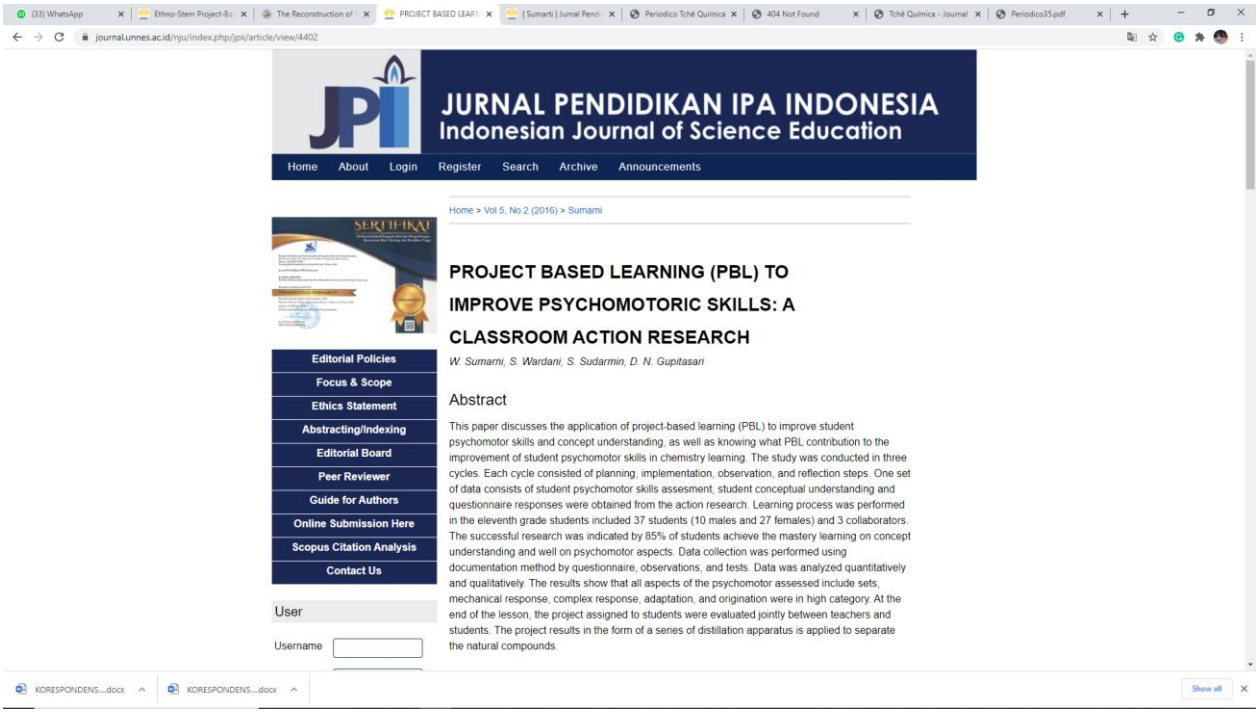
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W. Sumarni, S. Wardani, S. Sudarmin, D. N. Gupitasari
Abstract
This paper discusses the application of project-based learning (PBL) to improve student psychomotor skills and concept understanding, as well as knowing what PBL contribution to the improvement of student psychomotor skills in chemistry learning. The study was conducted in three cycles. Each cycle consisted of planning, implementation, observation, and reflection steps. One set of data consists of student psychomotor skills assesment, student conceptual understanding and questionnaire responses were obtained from the action research. Learning process was performed in the eleventh grade students included 37 students (10 males and 27 females) and 3 collaborators. The successful research was indicated by 85% of students achieve the mastery learning on concept understanding and well on psychomotor aspects. Data collection was performed using documentation method by questionnaire, observations, and tests. Data was analyzed quantitatively and qualitatively. The results show that all aspects of the psychomotor assessed include sets, mechanical response, complex response, adaptation, and origination were in high category. At the end of the lesson, the project assigned to students were evaluated jointly between teachers and students. The project results in the form of a series of distillation apparatus is applied to separate the natural compounds.
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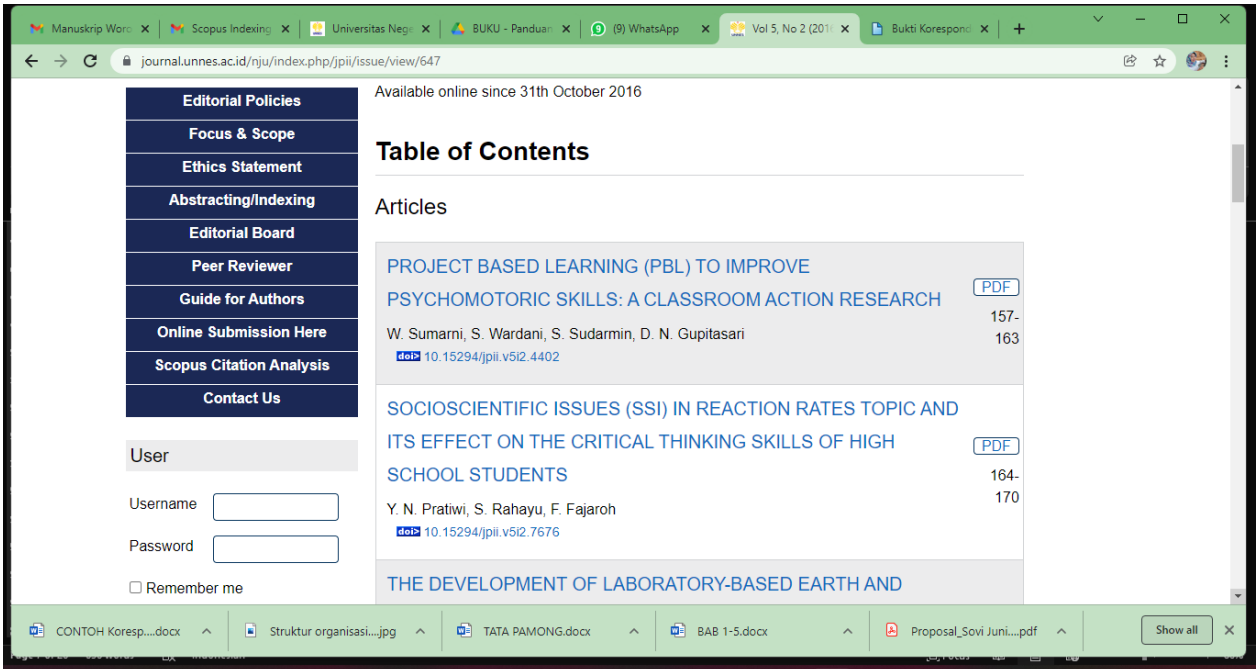
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Table of Contents
Articles
PROJECT BASED LEARNING (PBL) TO IMPROVE PSYCHOMOTORIC SKILLS: A CLASSROOM ACTION RESEARCH
PDF
157-163
W. Sumarni, S. Wardani, S. Sudarmin, D. N. Gupitasari
doi 10.15294/jpii.v5i2.4402
SOCIOSCIENTIFIC ISSUES (SSI) IN REACTION RATES TOPIC AND ITS EFFECT ON THE CRITICAL THINKING SKILLS OF HIGH SCHOOL STUDENTS
PDF
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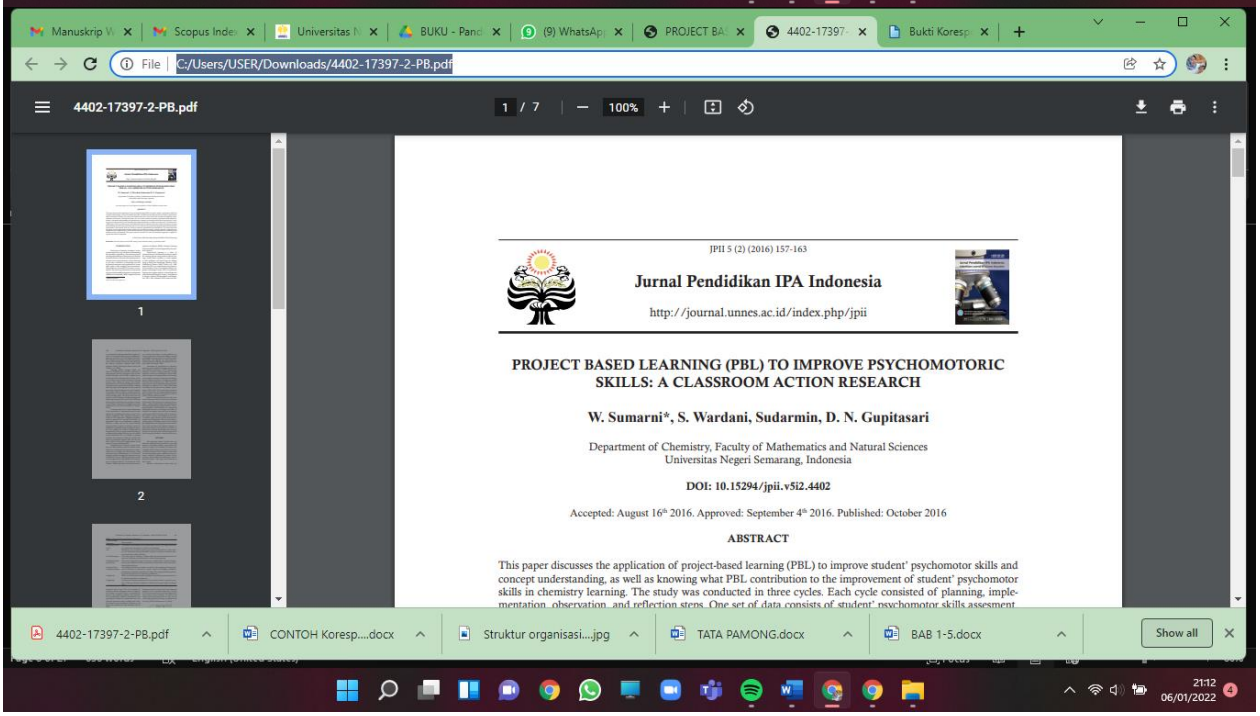
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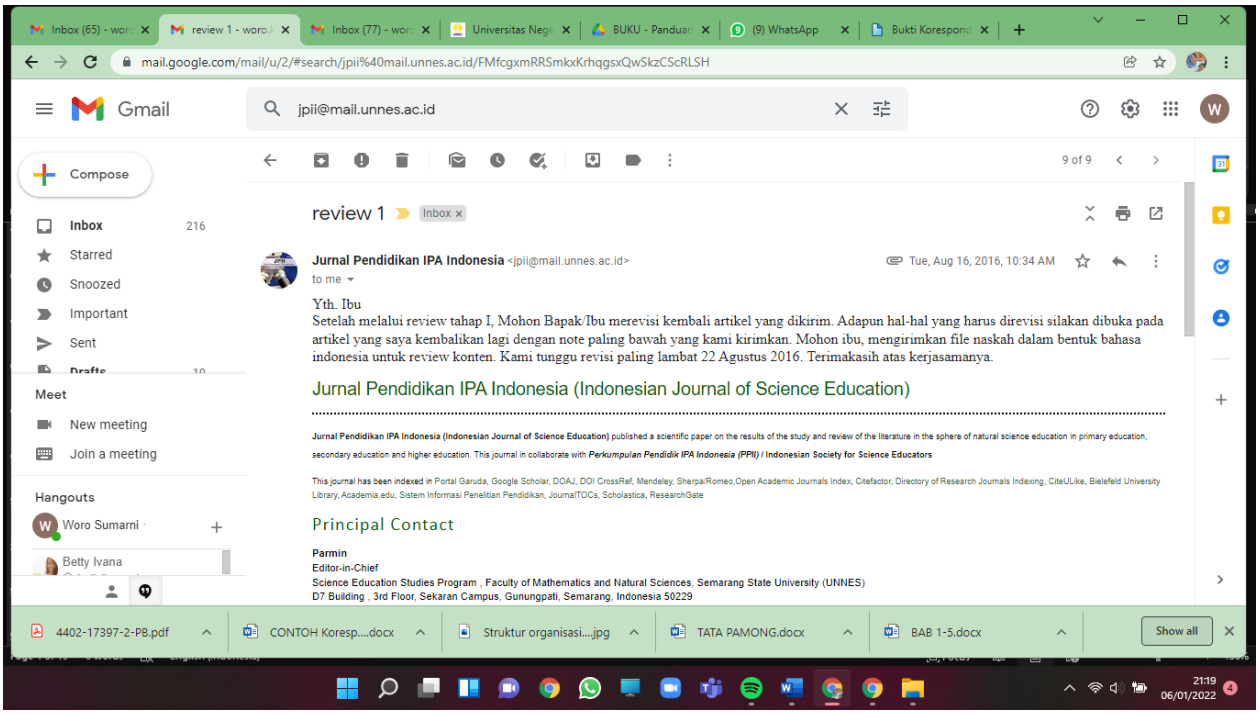

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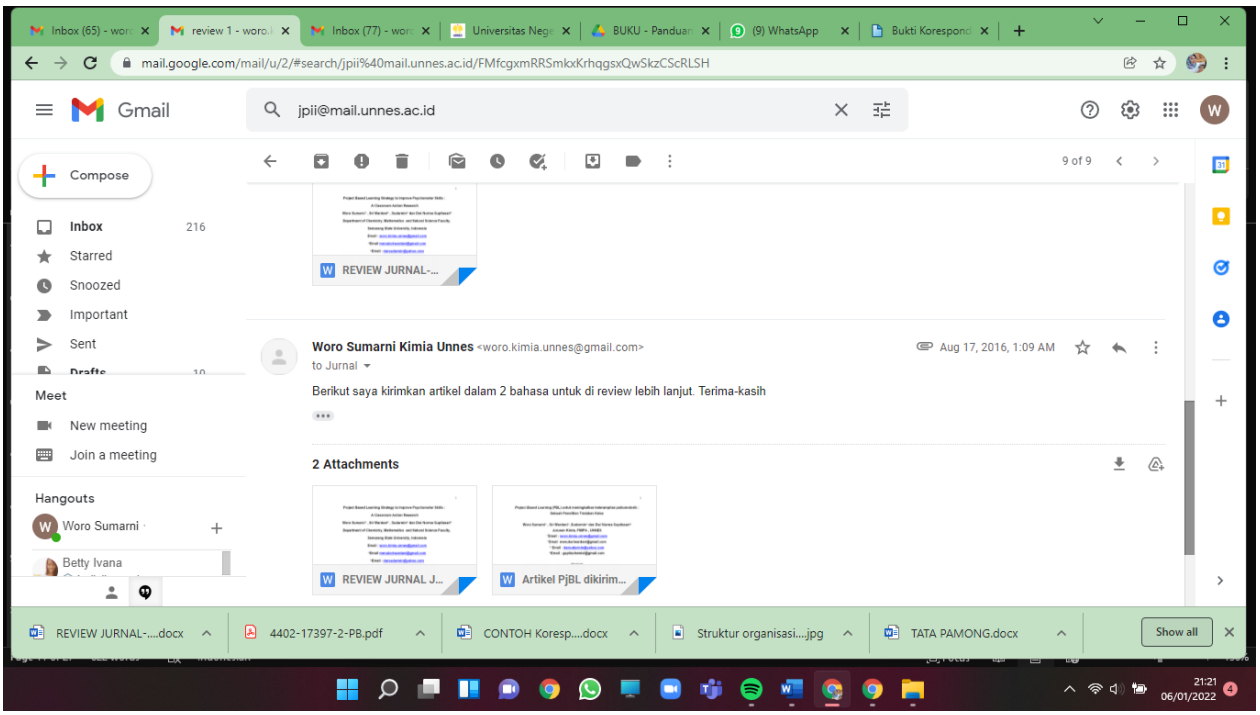

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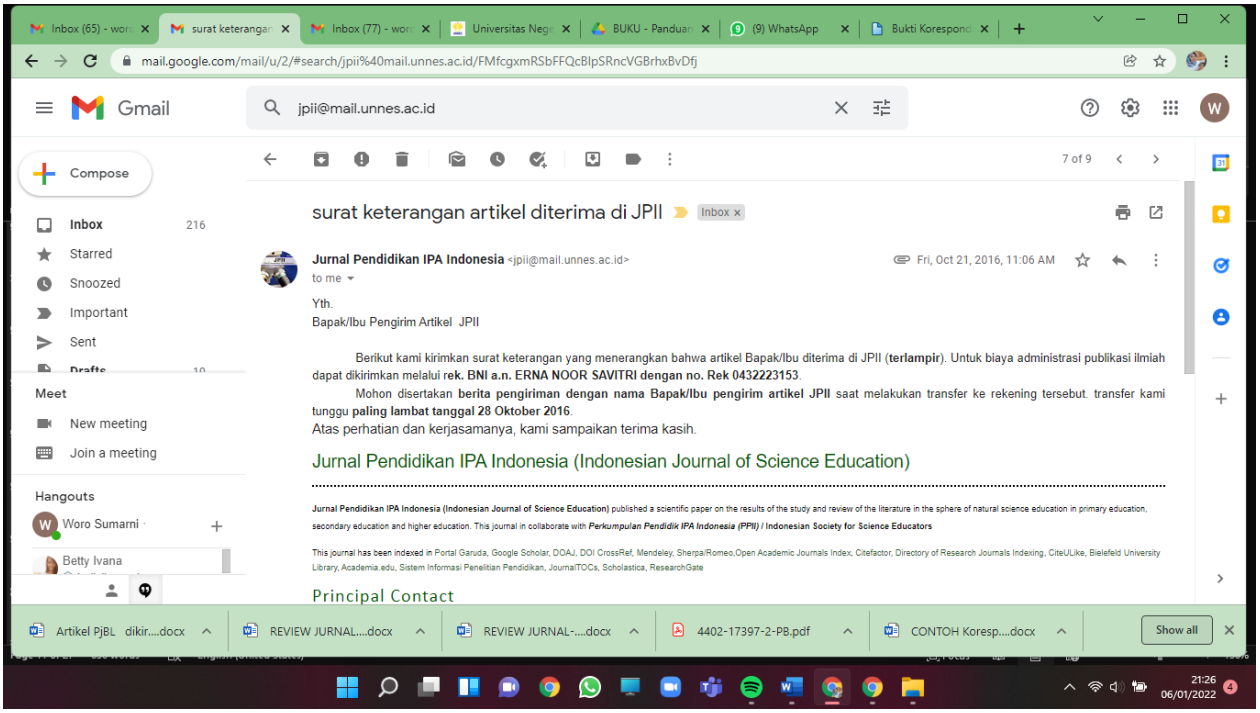

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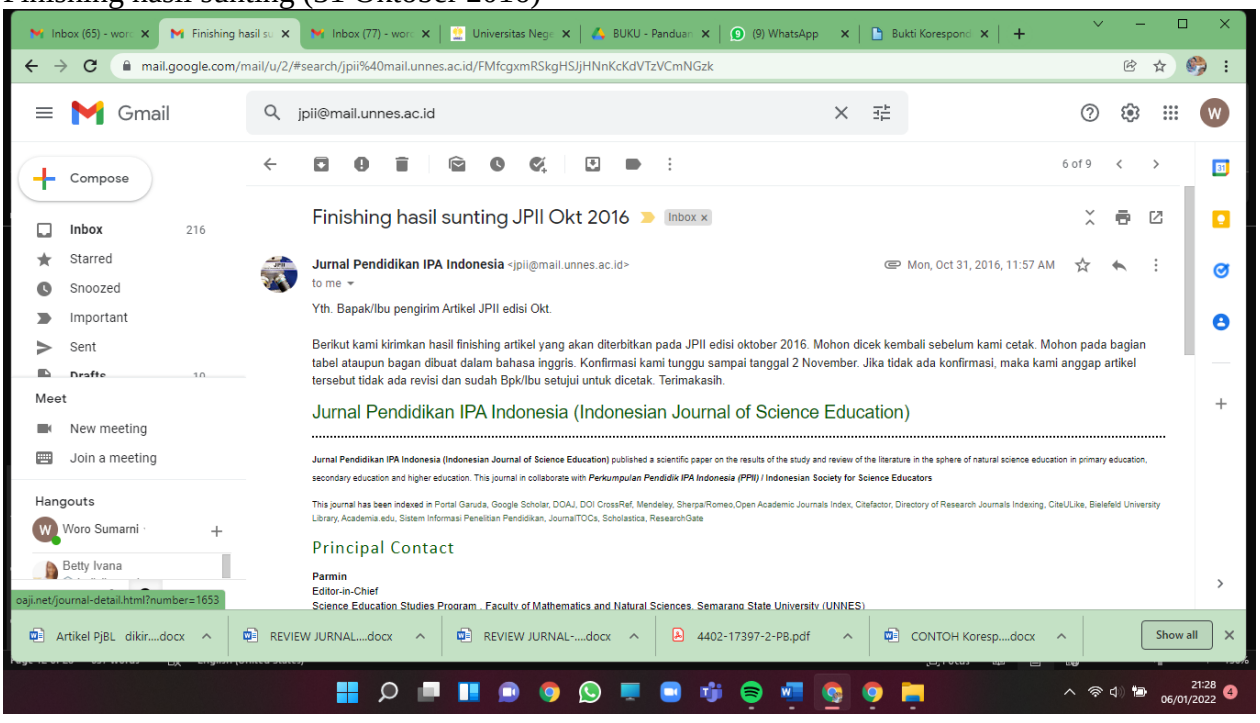

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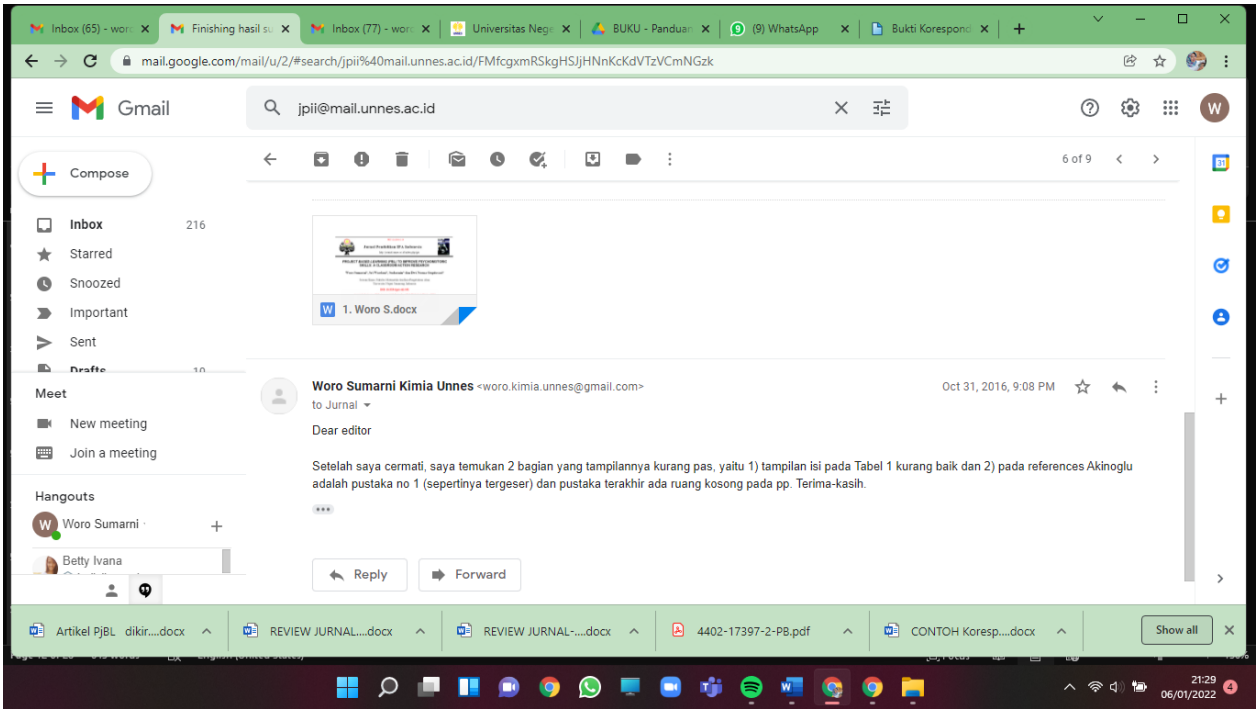

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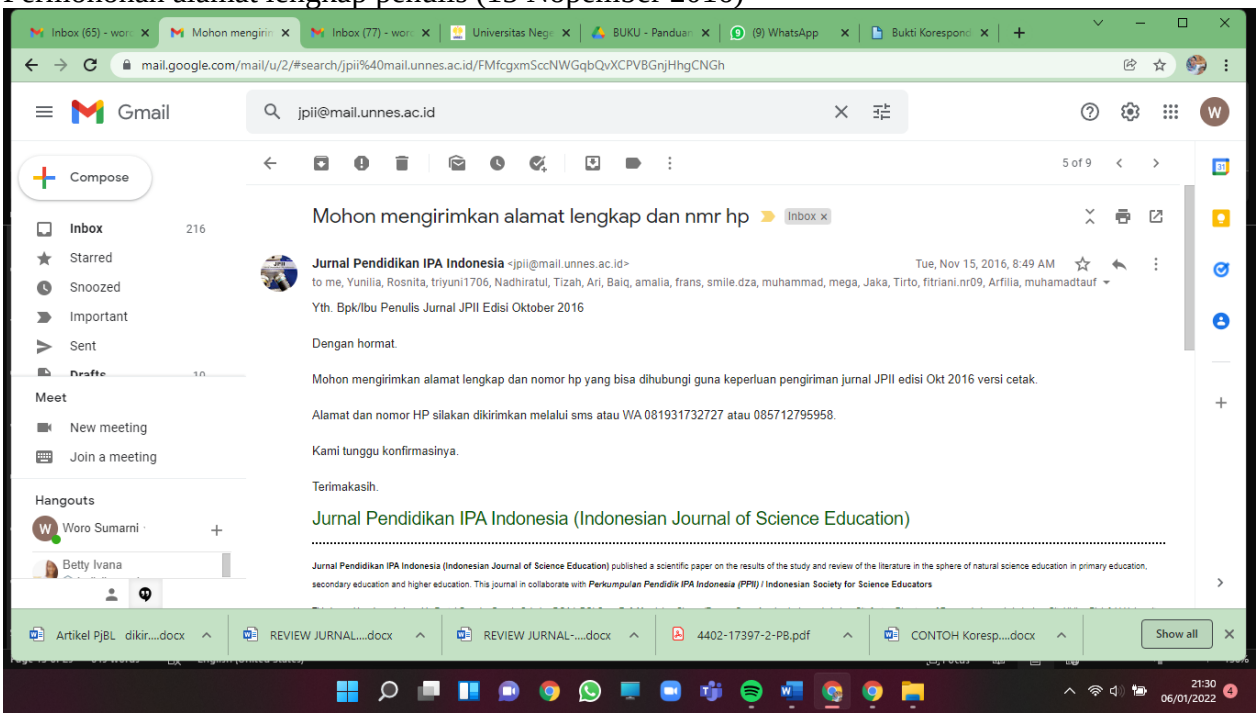

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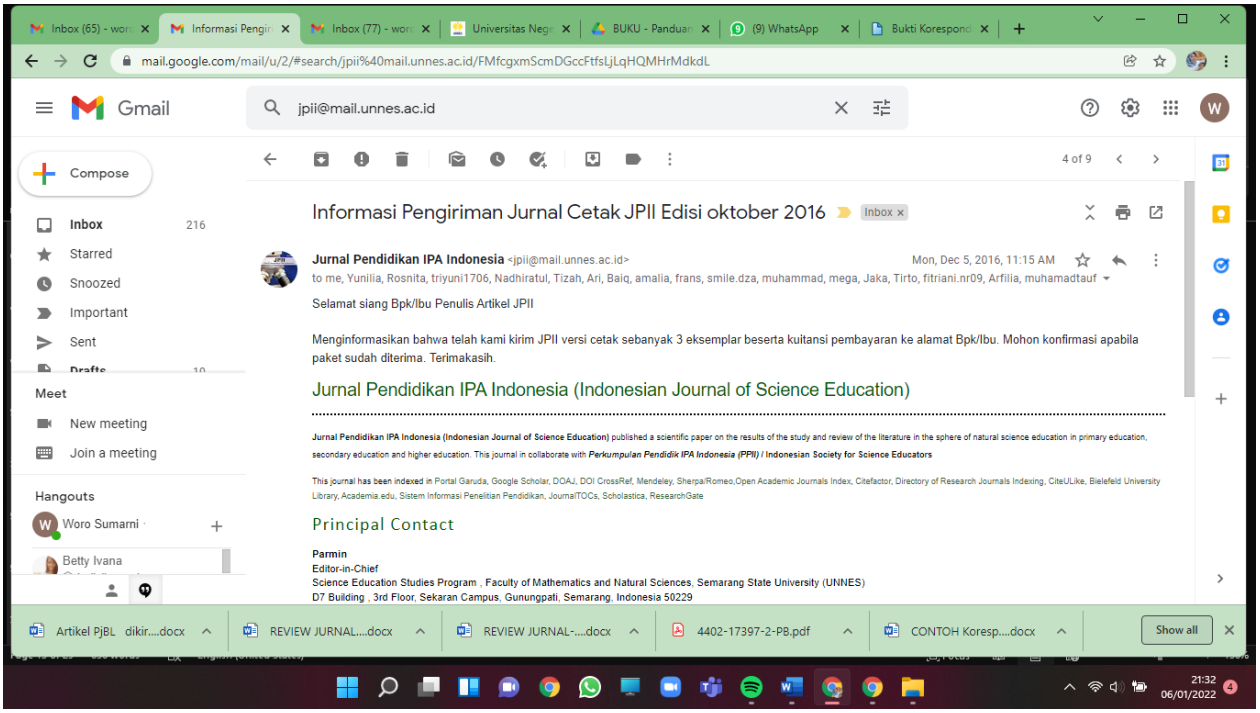
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Project Based Learning Strategy to Improve Psychomotor Skills : A Classroom Action Research

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Abstrak

Penelitian Tindakan Kelas ini bertujuan untuk mendeskripsikan strategi pembelajaran berbasis proyek (PBL) untuk meningkatkanketrampilan psikomotorik dan pemahaman konsep siswa , serta mengetahui apa saja kontribusi strategi PBL terhadap peningkatan ketrampilan psikomotorik siswa dalam pembelajaran kimia di Kelas X-1 SMA Teuku Umar Semarang. Penelitian dilakukan dalam 3 siklus. Masing-masing siklus terdiri atastahapan: perencanaan, pelaksanaan, observasi, dan refleksi. Peneliti mengambil data pada tiap siklus, yang terdiri dari data penilaian keterampilan psikomotor, data pemahaman konsep dan data angket tanggapan. Penelitian melibatkan 37 siswa (10 laki-laki dan 27 perempuan) dan 1 kolaborator. Kesimpulan dari Penelitian Tindakan Kelas ini adalah bahwa penerapan strategi PBL memberikan kontribusi positif terhadap peningkatan ketrampilan psikomotorik dan pemahaman konsep siswa . Dengan demikian , dalam upaya meningkatkan ketrampilan psikomotorik siswa, guru dapat menerapkan strategi PBL ini walaupun dalam bentuk mini proyek yang sederhana . Disarankan pula agar strategi PBL dapat dikembangkan ke dalam pelajaran yang lain, sehingga dapat bermanfaat bagi siswa untuk mengurangi kejenuhan dalam proses belajarnya .

Kata kunci : Penelitian Tindakan Kelas, Strategy pembelajaran berbasis proyek, Ketterampilan psikomotorik

Abstract

This paper discusses about Project-Based Learning (PBL) to increase psychomotor skills and student's concept comprehension, also to know the contribution of PBL towards student's psychomotor skills increasing in chemistry learning. The study was conducted in three cycles. Each cycle consisted of the following phases: planning, implementation, observation, and reflection. Each cycle consisted of psychomotor skills assessment data, concept understanding data and data questionnaire responses.This learning was applied on eleventh grader students involving 37 students (10 male and 27 female) also 3 collaborators. The indicator of research's success was minimum 85% of students achieved mastery learning on concept comprehension aspect and minimum was well-categorized on psychomotor aspect. Data analysis technique was conducted quantitatively and qualitatively. Data collection used the Documentation, Questionnaire, Observation, and Test. Action research result showed that every psychomotor aspects which were being measured included *set*, *mechanical response*, *complex response*, *adaptation*, and *origination* had been mastered in high category. In the end of learning, the project that was given to students was evaluated together between teachers and students group. The project result was distillation equipment chain which was made by the students, that was used to do the natural material compound separation.

Keywords : Classroom action research, PBL strategy, Project Based Learning, psychomotor skills

Introduction

Chemistry learning is usually not separated from practical work in the laboratory, which aims to make the concept and application of chemistry easier to be understood. By using the practical work-based learning, it could help students to find facts and theories they are learning in college. Psychomotor dimension is also important, because science naturally is not a horde of knowledge, but the result of human's hard work (human enterprises) which is liberated to psychomotor skills, for example equipment arrangement and measurement. Those skills is also useful for students in their daily life. In addition, practical work aims to improve psychomotor skills of the students(Millar & Abrahams, 2009). This is supported by the opinion of (Hofstein, 2004)who studied that chemistry would not be successful if not supported by the laboratory activities.

Project based learning is a form of constructivist and collaborative learningin which the learning process is student-centered, allowing several students to work together on a problem, and learn from each other as they co-construct knowledge (Whatley, 2012) (Gulbahar & Tinmaz, 2006). (Yalçin, et al., 2009) state that PBL is a comprehensive learning model for students of all ages, working individually or in groups to investigate topics existing in the environment. This kind of learning is a form of systematic learning that engages students in learning knowledge and skills through the development of the inquiry process to obtain a product (Widyatmoko & Pamelasari, 2012). It is also stated by (Sumarni, 2015) that PBL is a systematic teaching method that engages students in learning knowledge and skills through research tasks, authentic questions, and well-designed products. PBL also can increase creativity and psychomotor skills in students through learning activities

which result in products (Bell, 2010); (Doppelt, 2003); (Tiantong & Siksen, 2013); and (Yalçin, et al., 2009).

(Akinoglu, 2008), (Doppelt, 2003) and (Yalçin, et al., 2009) state that PBL is effective in improving students' performance by creating products through experimentation. With this PBL can actively involve students in those activity. During project finishing process, every potential owned by children can optimally develop. Students can increase psychomotor skills, thinking skills, creativity and imagination, so that students learning quality and process can increase . One of the project that can be given to students is to do educational visual-aid equipment. Visual-aid equipment can be used to give basic experience in experimenting and explaining concepts (Glaser & Carson, 2005) and also teachers should help students to visualize concept that is abstract into something real and easily comprehended by students (Pekbay & Kaptan, 2014).

One of the material that is need to be visualized is compound separation concept that is based on boiling point differential using distillation equipment chain. This compound separation concept is related to the material of solution colligative characteristic and the fraction separation of volatile oil. Because there is no distillation tool in school, so in this action research, students were given project assignment which was distillation tool chain production by using usable-free things around them and apply them for component separation in natural material. (Widyatmoko & Nurmasitah, 2013) commented on project-based learning with visual product, stating that student activity increased 25% from before making visual products. Besides students' activities, research result of (Deta, et al., 2013) also shows an association between PBL with improvement of students' skills with the increase of 55% on the skill aspect of assembling parts of visual aid.

Through practical activities,science educator can direct students to scientific work, give the students chance to comprehend and know environment, to observe and build the relation of cause and effect, to learn by hands-on activity (Hofstein & Lunetta, 2004). Besides, teachers can also increase students' confidence and motivation (Saad & BouJaoude, 2012)(ChanLin, 2008) to help them learn about themselves; to develop their problem solving, to develop psychomotor and mental skills, to give valuable learning, to increase analytical thinking skills, and to support the relation between science and daily life(Hofstein & Lunetta, 2004)(Mc Donnell, et al., 2007).

Psychomotor assessment in learning chemistry in accordance with students' skills can be enhanced through practical works (Aksela & Juntunen, 2013). The psychomotor domain is all about "doing" through imitation, practicing and habituating new skills, whereas the other two types of learning in Bloom's Taxonomy are the cognitive domain, focused on knowledge, and the affective domain focused on attitude (El-Sayed, 2011) (Witteck, et al., 2007).To develop psychomotor skills potential, could be developed by practical work in the laboratory (Witteck, et al., 2007) which aimed to the direction of children performance development (Tafa, 2012). The seven major categories, listed from the simplest behavior to the most complexas stated by Simson (1972)in (Clark, 2014),are listed in Table 1.

Table 1 *Simson's Psychomotor Domain of Taxonomy*

Level/learning Outcomes	**Characteristics**
Perception (awareness)	The ability to use sensory cues to guide motor activity. This ranges from sensory stimulation, through cue selection, to

	translation.
Set	Readiness to act. It includes mental, physical, and emotional sets. These three sets are dispositions that predetermine a person's response to different situations (sometimes called mindsets).
Guided Response	The early stages in learning a complex skill that includes imitation and trial and error. Adequacy of performance is achieved by practicing.
Mechanism (basic proficiency)	This is the intermediate stage in learning a complex skill. Learned responses have become habitual and the movements can be performed with some confidence and proficiency.
Complex Overt Response (Expert)	The skillful performance of motor acts that involve complex movement patterns. Proficiency is indicated by a quick, accurate, and highly coordinated performance, requiring a minimum of energy. This category includes performing without hesitation, and automatic performance.
Adaptation	Skills are well developed and the individual can modify movement patterns to fit special requirements. Adjustment.
Origination	Creating new movement patterns to fit a particular situation or specific problem. Learning outcomes emphasize creativity based upon highly developed skills.

Based on these background research studies, this action research was done. This research aimed to improve the understanding of the concept and psychomotor skills of students by having them produce a visual aid. The expected benefit of this research result, theoretically is to increase knowledge treasure about the usage of visual-aid instruments on the effort of material concreting that have abstract quality and to increase psychomotor skills. Practically, this PBL will (1) increase students concept comprehension about solution stem pressure and compound separation according to boiling point, (2) by using visual-aid equipment, students can see, feel, express by directly thinking about objects they are learning, abstract concept they are learning can be absorbed, are stuck and endure in students mind, (3) to increase students' knowledge about the usage og unusable things as learning assistance equipment, (4) to increase students' creativity and activity.

Methods

This classroom action research was conducted in collaboration with teachers in a senior high school in the city of Semarang. The subjects were 37 students of class X, contain of 23 female students and 14 male students. This action research refers to Spiral Kemmis & Mc Taggart model. There are 4 important stage in class action research, which are (1) planning, (2) action, (3) observation, and (4) reflection, occur a cycle as can be seen on Figure 1. This class action research was conducted on 3 cycles.

Indicators of the success of this research should be that a minimum of 75% of students achieve the passing grade both in the cognitive aspects as well as include in very good category in the psychomotor aspects. The data analysis techniques used are quantitatively and qualitatively.. Assessment in the psychomotor domain

requires that the skill be performed and observed, many times using a ranking scale to score the skill. Be aware of potential inter-rater reliability variances- clearly defining the criteria within the ranking scale or using multiple observers will reduce the potential variability.

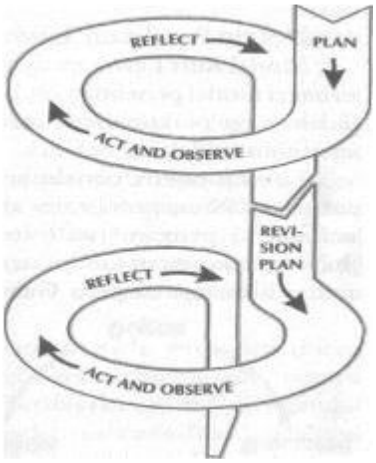
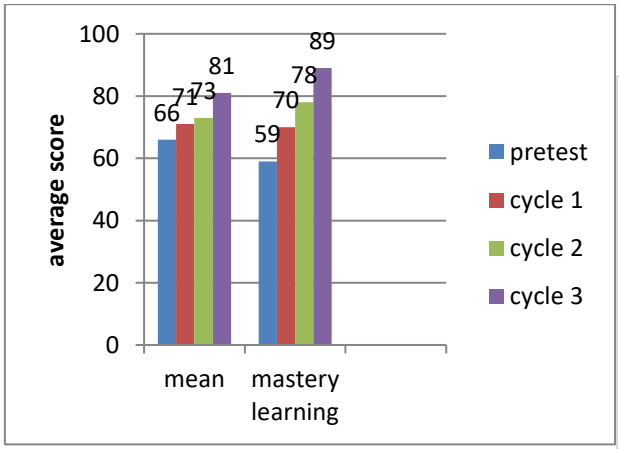


Figure 1. Spiral Kemmis & Mc Taggart Class Action Research Model

Simpson's approach to learning in the psychomotor domain has seven levels, starting with the simplest level of perception, set, guided response, mechanic response, complex response, adaptation, and origination.

Results and Discussions.

From the conducted research began from pra-cycle, cycle I until cycle III it was obtained data of cognitive learning result and classical completeness presentage, like can be seen on Figure 1.



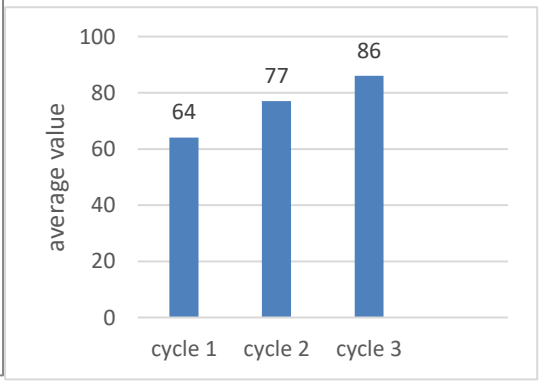


Figure 1. The average value of cognitive and completeness of classical study , n = 37.

Figure 2. The increase of the average value of students' psychomotor skills , n = 37

From Figure 1, it showed that on cycle I, students' cognitive learning result has not been classically appropriate to success indicators that is stated which is 75%. Success indicators was achieve on cycle 2. Based on Figure 1, it can be seen that cognitive learning result on second cycle, an improvement occurred with the same learning model as the previous cycle. The result of students' cognitive score in this cycle increased. The increase of students' cognitive score from cycle 1 to cycle 2 happened since most of the students felt enthusiastic in learning chemistry. In addition, the teacher gave them instructions to do orderly and directed learning, sebagaimana yang disampaikan Lee et al. (2012) dan Harman et al. (2016).However, action implementation still go through cycle 3, because in Figure 2, psychomotor skill success indicator was good, has not been achieved on cycle 2.

From Figure 2 dan Figure 3, the results of the study showed that the psychomotor aspect in cycle 1 which has not achieved the completeness, namely guided response, origination, perception, set and adaptation which has not achieved a good category yet.

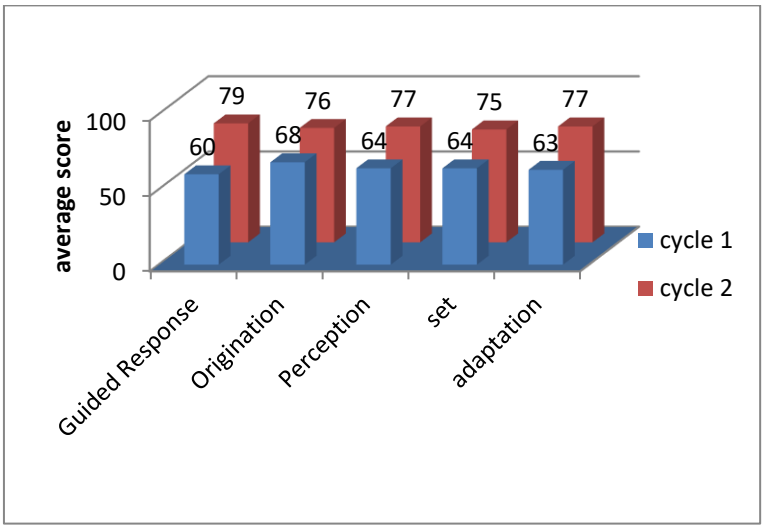


Figure 3. Results of the students' psychomotor skills in cycle 1 and 2.

In the first cycle, the skills of preparing tools, material and working solution was still low since the students had not comprehended well the components of

distillation visual aid and its function. In the set aspect, the students tended to pay less attention to the teacher's explanation on how to prepare distillation visual aid and how to put the working solution before distillation. In addition, the students were not accustomed to prepare the practical work tools and materials independently. Osuala & Onwuagboke (2014)that the students' ability in comprehending psychomotor aspect was still low, especially on the aspect of planning activity and using tools and materials.

Based on cycle 1 reflection result, it was conducted planning to do cycle 2. Learning implementation on cycle 2 is not really different from learning on cycle 1, but in the cycle 2, the groups did their project assignment which is the distillation tool series component preparation using unusable materials and apply the use on the next meeting.This is the product of making stage of the planned project in the first cycle. One of the distillation visual aids using waste material which was made by the students.

The result of students' skills in the second cycle can be seen in the Figure 3.On the contrary, students' psychomotor skill has generally increased. The five aspects assessed in this second cycle had reached good category, except the origination ascpect: students' visual aid product. Students' psychomotor aspects increasing in this second cycle was matched to the one said by Witteck et al. (2007) that laboratory does not only provide platform to learn by hands on activity, but also to gather scientific knowledge with different way (Lee et al. 2012) and contribute to students' psychomotor skill development.

Result of student skills for adaptation aspect is seen from the performance of students when the presentation and the students' understanding of the material included in the criteria of very high skill. In Figure 3, it is also seen that the guided

response aspect and origination (creativity) are already included in the criteria for high skills. This is consistent with the findings of Widiyatmoko and Pamelasari (2012) as well as Hakimzadeh et al. (2013) which stated that students was still experience difficulties in terms of producing and modifying the visual aids.Based on the reflection result of the implementation of the second cycle, planning and action implementation cycle 3 was focused to increase psychomotor skills to achieve very good category.

In the third cycle, students distillation practical work as well as the evaluation phase of the distillation visual aids product. On this third practical work, each group distilled different materials. Group I distilled frangipani, group II distilled roses, group III distilled magnolia flowers, and group IV distilled pandan leaves. Inthis aspect of thethird cyclein addition tothe five aspectswhich have beenassessedinpreviouscycles. There aretwoaspects thatare addedtoratednamelymechanicalresponsethat includesskills in usingpropsand skillsdo thecomplexdistillationandstringingresponsesmoothnessandfluency in thedistillingapparatus.

Results of students' skills in these distillation activities can be seen in Figure 4.

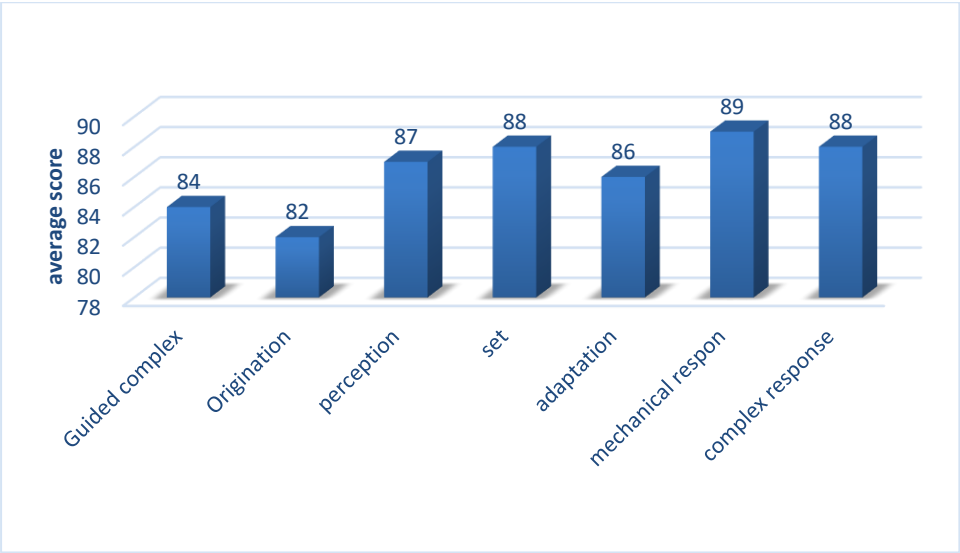


Figure 4. Practical Result at the End of the Cycles.

The third cycle wasused as a means of evaluation of visual aid products that have been made by the students. In this third practical work, the students did distillation practical work of natural materials. As shown in Figure 4, with the overall five psychomotor aspects assessed, students have been able to achieve very high skills. This condition is matched to statement of (Harman, et al., 2016) that learning in laboratory is important to increase learning quality by method that is stated as visualizing, materializing and application, observation and experiment. (Lee, et al., 2012) also stated that laboratory experience as a chance to problem solving on cognitive domain. Science teachers also said that, because the laboratory application they can teach the knowledge easier to their students and they can find interesting experience (Kibirige & Hodi, 2013) (Owolabi & Oginni, 2012); (Lee, et al., 2012) ; (Hofstein, 2004).If the students are trained on an ongoing basis can be increased due to the formation of experience in performing the complex skills. This is in accordance with (Rothgeb, 2008)who stated that the practical work can be done in collaboration to improve problem solving skills in identifying a practical hypothesis.

In the set aspect, the students have been able to prepare the tools, materials, and completeness of the practical work without the guidance of a teacher. Students have also been able to achieve the mechanical response and complex response aspects that are characterized by their smooth and skilled move in assembling and using distillation visual aids. This statement is also in accordance with C (Mioduser & Nadav, 2007)and (Sumarni, 2015)who stated that the use of visual aid in the PBL improves students' psychomotor so that it forms a positive learning skill.

However, for the third cycle which is the practical work of distilling natural materials, overall the groups' psychomotor skillsincreased. Widiyatmoko and Pamelasari (2012), (Gulbahar & Tinmaz, 2006) and (Deta, et al., 2013)who state that

PBL with visual aid products could improve students' psychomotorskills since students worked by finding skills to plan, organize, and create a consensus that can build soft skills.This was in accordance with the opinion of (ChanLin, 2008),(Yunus, et al., 2010), that PBL improved knowledge and the scientific work of students after practical work by using distillation aids made of unused material so that PBL could be applied to improve students' understanding of the material taught.(Harman, et al., 2016)also stated that cognitive skills need to be supported by psychomotor skills and affective skills.

This study certainly did not go smoothly; there were some constrains or barriers. This thing is suitable with the statement of (Mudulia, 2012) that there was a relation between source availability and knowledge achievement, with the reason that highly performance school has higher source and laboratory instrument availability and chemistry material than the lower one. This can lead the low-ability students lacking confidence in the presentation and practical work.(Makori & Onderi, 2013) and(Musasia, et al., 2012) said that the existence factors that can influence students' attitude level towards learning were comprehension level, anxiety, attendance, teachers' working burden, school's discipline and time management.

Most of students' response towards PBL according to open questionnaire were positive, with the reason that: enjoyable because they can directly change each other mind and discussion among students or teachers, this model was good and well-followed depends on the students' effort, can motivate in learning, can increase students' creativity and also make students to be more discipline.

Conclusions

Based on conducted action research result, it can be concluded that project assignment production application in form of distillation visual-aid equipment was

students centered laboratory learning that is highly needed and useful for students to develop in three learning domain; cognitive, affective, and psychomotor. Practice work plays an important role in creating link to daily life, to make students easier to comprehend learning, to make studied knowledge become permanent and to develop psychomotor skills and handcraft skills (Pekbay & Kaptan, 2014); (Kibirige & Hodi, 2013)(Owolabi & Oginni, 2012)(Saad & BouJaoude, 2012) ; (Tafa, 2012)(Millar & Abrahams, 2009) . There are many skills that can be obtained from this activity like skill of observation, measuring, classification, data recording, hypothesis production, data usage and to get scientific process skill like creating and changing model and variable controlling, and to do an experiment.

PBL with a distillation visual aid can improve students' psychomotor skill. However, it is suggested that when a teacher is going to implement PBL with visual aid product, he should consider the ability of students with the project to be implemented. This was important since the application of learning by making a product,when it is not match with the ability of students, could lead to less optimal results so tht it would be far from what has been expected.

Since the purpose of this research was to help students in the practical work, the practical work that was constrained by the limited laboratory equipment, could be done by making other visual aids using waste material. Hence, PBL can be further developed to overcome the constraints of the implementation of practical works such as the electrolysis process, practical work to understand the characteristics of colloid, the law of mass conservation, and so on.

Acknowledgements

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Note : 2 daftar pustaka yang saya tanda merah, tidak ada dalam konten

: mohon ibu untuk mengirimkan naskahnya untuk review konten.

Terimakasih atas kerjasama dari ibu... ☺

Hasil Revisi sesuai masukan reviewer

Project Based Learning Strategy to Improve Psychomotor Skills : A Classroom Action Research

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Abstrak

Penelitian Tindakan Kelas ini bertujuan untuk mendeskripsikan strategi pembelajaran berbasis proyek (PBL) untuk meningkatkanketrampilan psikomotorik dan pemahaman konsep siswa , serta mengetahui apa saja kontribusi strategi PBL terhadap peningkatan ketrampilan psikomotorik siswa dalam pembelajaran kimia di Kelas X-1 SMA Teuku Umar Semarang. Penelitian dilakukan dalam 3 siklus. Masing-masing siklus terdiri atastahapan: perencanaan, pelaksanaan, observasi, dan refleksi. Peneliti mengambil data pada tiap siklus, yang terdiri dari data penilaian keterampilan psikomotor, data pemahaman konsep dan data angket tanggapan. Penelitian melibatkan 37 siswa (10 laki-laki dan 27 perempuan) dan 1 kolaborator. Kesimpulan dari Penelitian Tindakan Kelas ini adalah bahwa penerapan strategi PBL memberikan kontribusi positif terhadap peningkatan ketrampilan psikomotorik dan pemahaman konsep siswa . Dengan demikian , dalam upaya meningkatkan ketrampilan psikomotorik siswa, guru dapat menerapkan strategi PBL ini walaupun dalam bentuk mini proyek yang sederhana . Disarankan pula agar strategi PBL dapat dikembangkan ke dalam pelajaran yang lain, sehingga dapat bermanfaat bagi siswa untuk mengurangi kejenuhan dalam proses belajarnya .

Kata kunci : Penelitian Tindakan Kelas, Strategy pembelajaran berbasis proyek, Ketterampilan psikomotorik

Abstract

This paper discusses about Project-Based Learning (PBL) to increase psychomotor skills and student's concept comprehension, also to know the contribution of PBL towards student's psychomotor skills increasing in chemistry learning. The study was conducted in three cycles. Each cycle consisted of the following phases: planning, implementation, observation, and reflection. Each cycle consisted of psychomotor skills assessment data, concept understanding data and data questionnaire responses.This learning was applied on eleventh grader students involving 37 students (10 male and 27 female) also 3 collaborators. The indicator of research's success was minimum 85% of students achieved mastery learning on concept comprehension aspect and minimum was well-categorized on psychomotor aspect. Data analysis technique was conducted quantitatively and qualitatively. Data collection used the Documentation, Questionnaire, Observation, and Test. Action research result showed that every psychomotor aspects which were being measured included *set*, *mechanical response*, *complex response*, *adaptation*, and *origination* had been mastered in high category. In the end of learning, the project that was given to students was evaluated together between teachers and students group. The project result was distillation equipment chain which was made by the students, that was used to do the natural material compound separation.

Keywords : Classroom action research, PBL strategy, Project Based Learning, psychomotor skills

Introduction

Chemistry learning is usually not separated from practical work in the laboratory, which aims to make the concept and application of chemistry easier to be understood. By using the practical work-based learning, it could help students to find facts and theories they are learning in college. Psychomotor dimension is also important, because science naturally is not a horde of knowledge, but the result of human's hard work (human enterprises) which is liberated to psychomotor skills, for example equipment arrangement and measurement. Those skills is also useful for students in their daily life. In addition, practical work aims to improve psychomotor skills of the students(Millar & Abrahams, 2009). This is supported by the opinion of (Hofstein, 2004)who studied that chemistry would not be successful if not supported by the laboratory activities.

Project based learning is a form of constructivist and collaborative learning which the learning process is student-centered, allowing several students to work together on a problem, and learn from each other as they co-construct knowledge (Whatley, 2012) (Gulbahar & Tinmaz, 2006). (Yalçin, et al., 2009) state that PBL is a comprehensive learning model for students of all ages, working individually or in groups to investigate topics existing in the environment. This kind of learning is a form of systematic learning that engages students in learning knowledge and skills through the development of the inquiry process to obtain a product (Widyatmoko & Pamelasari, 2012). It is also stated by (Sumarni, 2015) that PBL is a systematic teaching method that engages students in learning knowledge and skills through research tasks, authentic questions, and well-designed products. PBL also can increase creativity and psychomotor skills in students through learning activities

which result in products (Bell, 2010); (Doppelt, 2003); (Tiantong & Siksen, 2013); and (Yalçin, et al., 2009).

(Akinoglu, 2008), (Doppelt, 2003) and (Yalçin, et al., 2009) state that PBL is effective in improving students' performance by creating products through experimentation. With this PBL can actively involve students in those activity. During project finishing process, every potential owned by children can optimally develop. Students can increase psychomotor skills, thinking skills, creativity and imagination, so that students learning quality and process can increase . One of the project that can be given to students is to do educational visual-aid equipment. Visual-aid equipment can be used to give basic experience in experimenting and explaining concepts (Glaser & Carson, 2005) and also teachers should help students to visualize concept that is abstract into something real and easily comprehended by students (Pekbay & Kaptan, 2014).

One of the material that is need to be visualized is compound separation concept that is based on boiling point differential using distillation equipment chain. This compound separation concept is related to the material of solution colligative characteristic and the fraction separation of volatile oil. Because there is no distillation tool in school, so in this action research, students were given project assignment which was distillation tool chain production by using usable-free things around them and apply them for component separation in natural material. (Widyatmoko & Nurmasitah, 2013) commented on project-based learning with visual product, stating that student activity increased 25% from before making visual products. Besides students' activities, research result of (Deta, et al., 2013) also shows an association between PBL with improvement of students' skills with the increase of 55% on the skill aspect of assembling parts of visual aid.

Through practical activities,science educator can direct students to scientific work, give the students chance to comprehend and know environment, to observe and build the relation of cause and effect, to learn by hands-on activity (Hofstein & Lunetta, 2004). Besides, teachers can also increase students' confidence and motivation (Saad & BouJaoude, 2012)(ChanLin, 2008) to help them learn about themselves; to develop their problem solving, to develop psychomotor and mental skills, to give valuable learning, to increase analytical thinking skills, and to support the relation between science and daily life(Hofstein & Lunetta, 2004)(Mc Donnell, et al., 2007).

Psychomotor assessment in learning chemistry in accordance with students' skills can be enhanced through practical works (Aksela & Juntunen, 2013). The psychomotor domain is all about "doing" through imitation, practicing and habituating new skills, whereas the other two types of learning in Bloom's Taxonomy are the cognitive domain, focused on knowledge, and the affective domain focused on attitude (El-Sayed, 2011) (Witteck, et al., 2007).To develop psychomotor skills potential, could be developed by practical work in the laboratory (Witteck, et al., 2007) which aimed to the direction of children performance development (Tafa, 2012). The seven major categories, listed from the simplest behavior to the most complexas stated by Simson (1972)in (Clark, 2014),are listed in Table 1.

Table 1 *Simson's Psychomotor Domain of Taxonomy*

Level/learning Outcomes	**Characteristics**
Perception (awareness)	The ability to use sensory cues to guide motor activity. This ranges from sensory stimulation, through cue selection, to

	translation.
Set	Readiness to act. It includes mental, physical, and emotional sets. These three sets are dispositions that predetermine a person's response to different situations (sometimes called mindsets).
Guided Response	The early stages in learning a complex skill that includes imitation and trial and error. Adequacy of performance is achieved by practicing.
Mechanism (basic proficiency)	This is the intermediate stage in learning a complex skill. Learned responses have become habitual and the movements can be performed with some confidence and proficiency.
Complex Overt Response (Expert)	The skillful performance of motor acts that involve complex movement patterns. Proficiency is indicated by a quick, accurate, and highly coordinated performance, requiring a minimum of energy. This category includes performing without hesitation, and automatic performance.
Adaptation	Skills are well developed and the individual can modify movement patterns to fit special requirements. Adjustment.
Origination	Creating new movement patterns to fit a particular situation or specific problem. Learning outcomes emphasize creativity based upon highly developed skills.

Based on these background research studies, this action research was done. This research aimed to improve the understanding of the concept and psychomotor skills of students by having them produce a visual aid. The expected benefit of this research result, theoretically is to increase knowledge treasure about the usage of visual-aid instruments on the effort of material concreting that have abstract quality and to increase psychomotor skills. Practically, this PBL will (1) increase students concept comprehension about solution stem pressure and compound separation according to boiling point, (2) by using visual-aid equipment, students can see, feel, express by directly thinking about objects they are learning, abstract concept they are learning can be absorbed, are stuck and endure in students mind, (3) to increase students' knowledge about the usage og unusable things as learning assistance equipment, (4) to increase students' creativity and activity.

Methods

This classroom action research was conducted in collaboration with teachers in a senior high school in the city of Semarang. The subjects were 37 students of class X, contain of 23 female students and 14 male students. This action research refers to Spiral Kemmis & Mc Taggart model. There are 4 important stage in class action research, which are (1) planning, (2) action, (3) observation, and (4) reflection, occur a cycle as can be seen on Figure 1. This class action research was conducted on 3 cycles.

Indicators of the success of this research should be that a minimum of 75% of students achieve the passing grade both in the cognitive aspects as well as include in very good category in the psychomotor aspects. The data analysis techniques used are quantitatively and qualitatively.. Assessment in the psychomotor domain

requires that the skill be performed and observed, many times using a ranking scale to score the skill. Be aware of potential inter-rater reliability variances- clearly defining the criteria within the ranking scale or using multiple observers will reduce the potential variability.

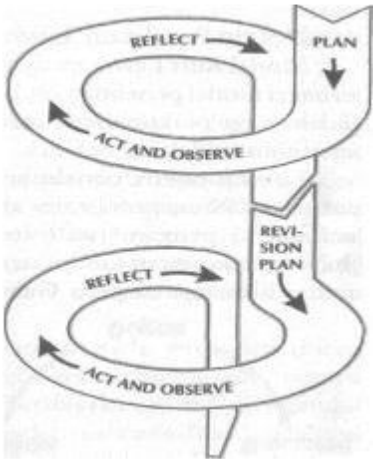
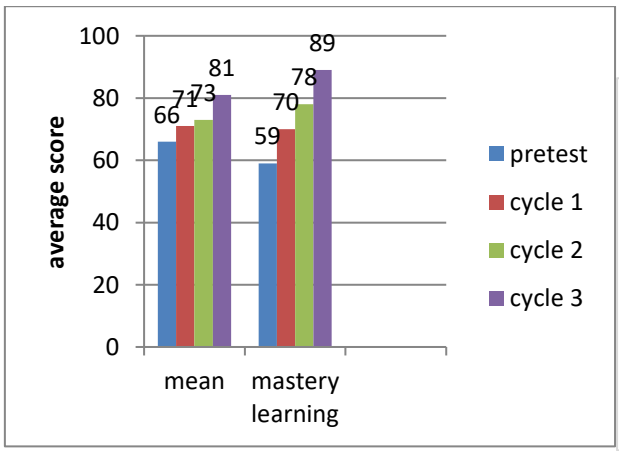


Figure 1. Spiral Kemmis & Mc Taggart Class Action Research Model

Simpson's approach to learning in the psychomotor domain has seven levels, starting with the simplest level of perception, set, guided response, mechanic response, complex response, adaptation, and origination.

Results and Discussions.

From the conducted research began from pra-cycle, cycle I until cycle III it was obtained data of cognitive learning result and classical completeness presentage, like can be seen on Figure 1.



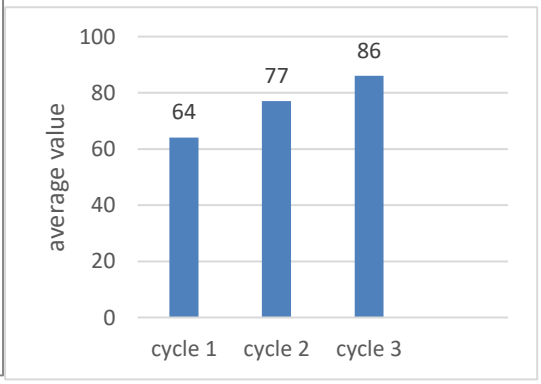


Figure 1. The average value of cognitive and completeness of classical study , n = 37.

Figure 2. The increase of the average value of students' psychomotor skills , n = 37

From Figure 1, it showed that on cycle I, students' cognitive learning result has not been classically appropriate to success indicators that is stated which is 75%. Success indicators was achieve on cycle 2. Based on Figure 1, it can be seen that cognitive learning result on second cycle, an improvement occurred with the same learning model as the previous cycle. The result of students' cognitive score in this cycle increased. The increase of students' cognitive score from cycle 1 to cycle 2 happened since most of the students felt enthusiastic in learning chemistry. In addition, the teacher gave them instructions to do orderly and directed learning, sebagaimana yang disampaikan Lee et al. (2012) dan Harman et al. (2016).However, action implementation still go through cycle 3, because in Figure 2, psychomotor skill success indicator was good, has not been achieved on cycle 2.

From Figure 2 dan Figure 3, the results of the study showed that the psychomotor aspect in cycle 1 which has not achieved the completeness, namely guided response, origination, perception, set and adaptation which has not achieved a good category yet.

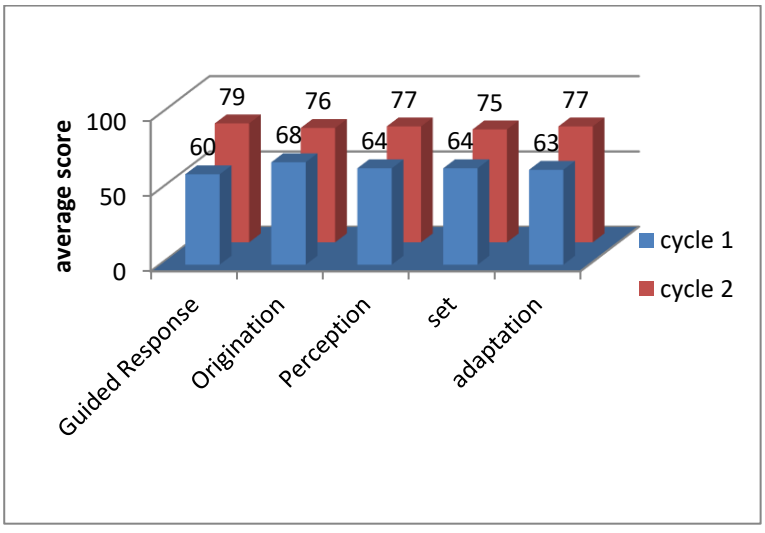


Figure 3. Results of the students' psychomotor skills in cycle 1 and 2.

In the first cycle, the skills of preparing tools, material and working solution was still low since the students had not comprehended well the components of distillation visual aid and its function. In the set aspect, the students tended to pay less attention to

the teacher's explanation on how to prepare distillation visual aid and how to put the working solution before distillation. In addition, the students were not accustomed to prepare the practical work tools and materials independently. Osuala & Onwuagboke (2014) that the students' ability in comprehending psychomotor aspect was still low, especially on the aspect of planning activity and using tools and materials.

Based on cycle 1 reflection result, it was conducted planning to do cycle 2. Learning implementation on cycle 2 is not really different from learning on cycle 1, but in the cycle 2, the groups did their project assignment which is the distillation tool series component preparation using unusable materials and apply the use on the next meeting.This is the product of making stage of the planned project in the first cycle. One of the distillation visual aids using waste material which was made by the students.

The results of cognitive aspects obtained in this second cycle students have increased. compared with the cycle I. Improved cognitive value of students from the first cycle to the second cycle occurs because most of the students began to enthusiastically participated in chemistry learning and teachers have given signs that learning takes place in an orderly and purposeful. The result of students' skills in the second cycle can be seen in the Figure 3.On the contrary, students' psychomotor skill has generally increased. The five aspects assessed in this second cycle had reached good category, except the origination ascpect: students' visual aid product. Students' psychomotor aspects increasing in this second cycle was matched to the one said by Witteck et al. (2007) that laboratory does not only provide platform to learn by hands on activity, but also to gather scientific knowledge with different way (Lee et al. 2012) and contribute to students' psychomotor skill development.

Result of student skills for adaptation aspect is seen from the performance of students when the presentation and the students' understanding of the material included in the criteria of very high skill. In Figure 3, it is also seen that the guided response aspect and origination (creativity) are already included in the criteria for high skills. This

is consistent with the findings of Widiyatmoko and Pamelasari (2012) as well as Hakimzadeh et al. (2013) which stated that students was still experience difficulties in terms of producing and modifying the visual aids.Based on the reflection result of the implementation of the second cycle, planning and action implementation cycle 3 was focused to increase psychomotor skills to achieve very good category.

In the third cycle, students distillation practical work as well as the evaluation phase of the distillation visual aids product. On this third practical work, each group distilled different materials. Group I distilled frangipani, group II distilled roses, group III distilled magnolia flowers, and group IV distilled pandan leaves. In the third cycle there is the addition of two aspects of the five aspects which have been assessed during the previous cycle, namely mechanical responses that include skills in using tools to perform complex distillation response and smoothness in operating a series of distillation apparatus.

Results of students' skills in these distillation activities can be seen in Figure 4.

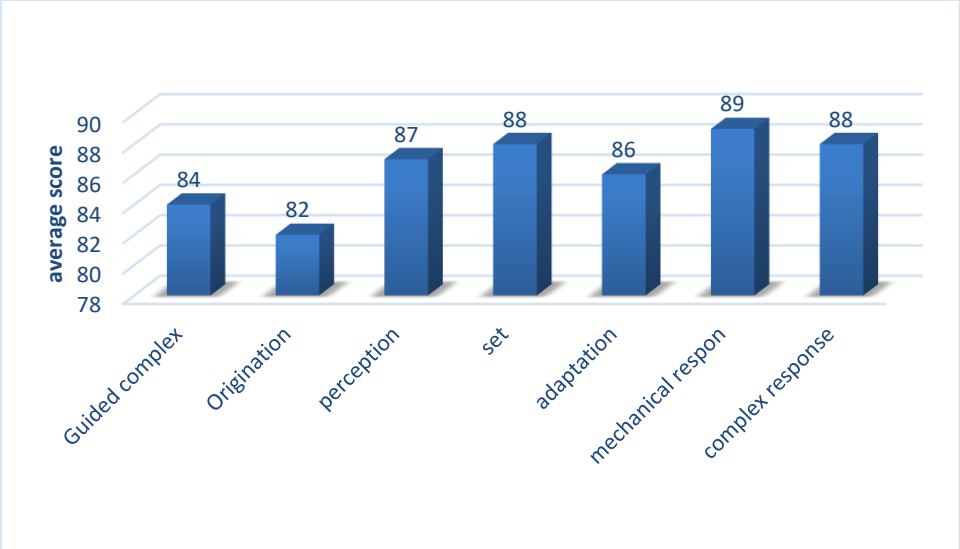


Figure 4. Practical Result at the End of the Cycles.

The third cycle was used as a means of evaluation of visual aid products that have been made by the students. In this third practical work, the students did distillation practical work of natural materials. As shown in Figure 4, with the overall five psychomotor aspects assessed, students have been able to achieve very high skills.

This condition is matched to statement of (Harman, et al., 2016) that learning in laboratory is important to increase learning quality by method that is stated as visualizing, materializing and application, observation and experiment. (Lee, et al., 2012) also stated that laboratory experience as a chance to problem solving on cognitive domain. Science teachers also said that, because the laboratory application they can teach the knowledge easier to their students and they can find interesting experience (Kibirige & Hodi, 2013) (Owolabi & Oginni, 2012); (Lee, et al., 2012) ; (Hofstein, 2004).If the students are trained on an ongoing basis can be increased due to the formation of experience in performing the complex skills. This is in accordance with (Rothgeb, 2008) who stated that the practical work can be done in collaboration to improve problem solving skills in identifying a practical hypothesis.

In the set aspect, the students have been able to prepare the tools, materials, and completeness of the practical work without the guidance of a teacher. Students have also been able to achieve the mechanical response and complex response aspects that are characterized by their smooth and skilled move in assembling and using distillation visual aids. This statement is also in accordance with C (Mioduser & Nadav, 2007)and (Sumarni, 2015)who stated that the use of visual aid in the PBL improves students' psychomotor so that it forms a positive learning skill.

However, for the third cycle which is the practical work of distilling natural materials, overall the groups' psychomotor skillsincreased. Widiyatmoko and Pamelasari (2012), (Gulbahar & Tinmaz, 2006) and (Deta, et al., 2013)who state that PBL with visual aid products could improve students' psychomotorskills since students worked by finding skills to plan, organize, and create a consensus that can build soft skills.This was in accordance with the opinion of (ChanLin, 2008),(Yunus, et al., 2010), that PBL improved knowledge and the scientific work of students after practical work by using distillation aids made of unused material so that PBL could be applied to improve

students' understanding of the material taught.(Harman, et al., 2016)also stated that cognitive skills need to be supported by psychomotor skills and affective skills.

This study certainly did not go smoothly; there were some constrains or barriers. This thing is suitable with the statement of (Mudulia, 2012) that there was a relation between source availability and knowledge achievement, with the reason that highly performance school has higher source and laboratory instrument availability and chemistry material than the lower one. This can lead the low-ability students lacking confidence in the presentation and practical work.(Makori & Onderi, 2013) and(Musasia, et al., 2012) said that the existence factors that can influence students' attitude level towards learning were comprehension level, anxiety, attendance, teachers' working burden, school's discipline and time management.

Most of students' response towards PBL according to open questionnaire were positive, with the reason that: enjoyable because they can directly change each other mind and discussion among students or teachers, this model was good and well-followed depends on the students' effort, can motivate in learning, can increase students' creativity and also make students to be more discipline.

Conclusions

An overview of the project work in science education, suggesting that the focus remains on cognitive skills. However, cognitive skills need to be supported properly by the psychomotor skills and affective skills. Science teachers believe, thanks to laboratory applications they can teach science more easily to their students, they can be successful and scientific process skills of students increased (Myers & Dyer, 2006).

Based on conducted action research result, it can be concluded that project assignment production application in form of distillation visual-aid equipment was students centered laboratory learning that is highly needed and useful for students to develop in three learning domain; cognitive, affective, and psychomotor. Practice work plays an important role in creating link to daily life, to make students easier to

comprehend learning, to make studied knowledge become permanent and to develop psychomotor skills and handcraft skills (Pekbay & Kaptan, 2014); (Kibirige & Hodi, 2013)(Owolabi & Oginni, 2012)(Saad & BouJaoude, 2012) ; (Tafa, 2012)(Millar & Abrahams, 2009) . There are many skills that can be obtained from this activity like skill of observation, measuring, classification, data recording, hypothesis production, data usage and to get scientific process skill like creating and changing model and variable controlling, and to do an experiment.

PBL with a distillation visual aid can improve students' psychomotor skill. However, it is suggested that when a teacher is going to implement PBL with visual aid product, he should consider the ability of students with the project to be implemented. This was important since the application of learning by making a product,when it is not match with the ability of students, could lead to less optimal results so tht it would be far from what has been expected.

Since the purpose of this research was to help students in the practical work, the practical work that was constrained by the limited laboratory equipment, could be done by making other visual aids using waste material. Hence, PBL can be further developed to overcome the constraints of the implementation of practical works such as the electrolysis process, practical work to understand the characteristics of colloid, the law of mass conservation, and so on.

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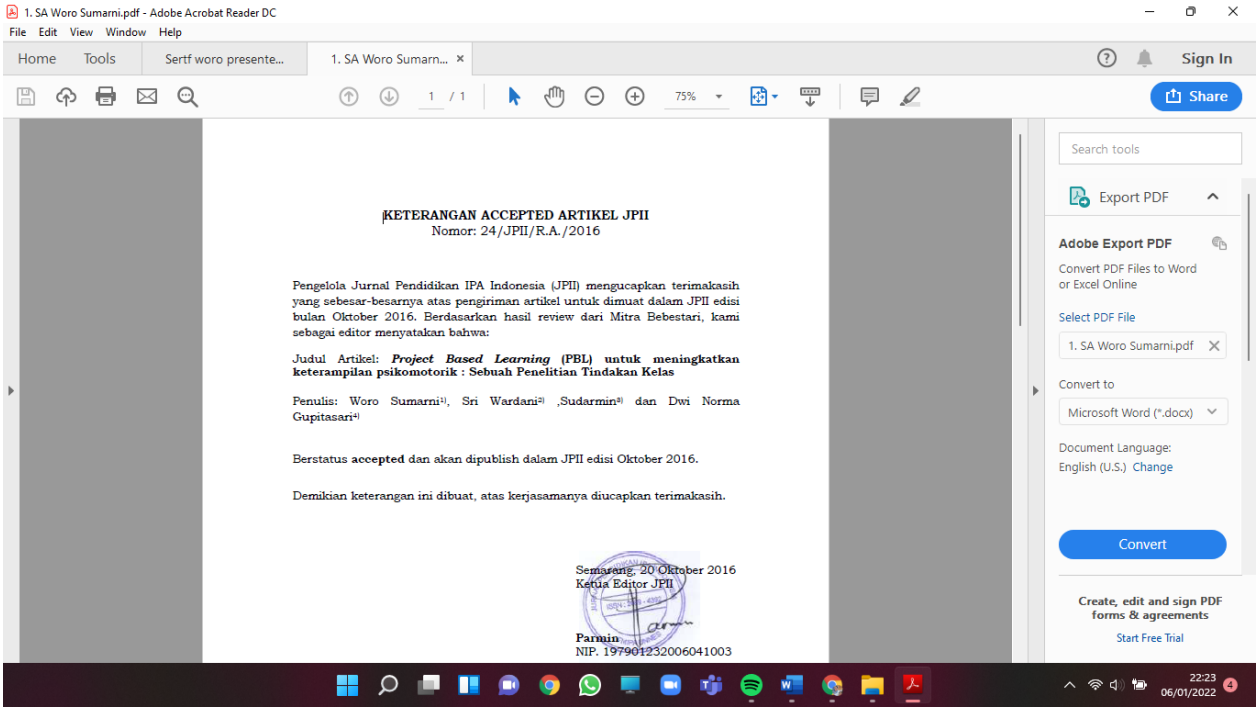

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Penulis: Woro Sumarni[1)], Sri Wardani[2)] ,Sudarmin[3)] dan Dwi Norma Gupitasari[4)]

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