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Article

Scaring Interest in Learning Chemistry Based on Career Interest Through Ecolectrochemistry: Presenting Inclusive Chemistry in Online Class

Zulfah[1], Benny Yodi[2]*

[1]STAIN Sultan Abdurrahman, Kepulauan Riau, Indonesia
[2] SMA Katolik Santu Petrus, Pontianak, Indonesia

Corresponding Address: benny@smapetrus.net

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ABSTRACT
The online learning of organic chemistry series chemistry in class XII MIPA Catholic SMA Santu Petrus Pontianak in the first three months of the odd semester showed a decrease in interest in learning chemistry. This study was conducted to find chemistry lessons that match the career interests of students, especially the study topics in the physical chemistry learning series (voltaic cells and electrolytic cells). On the topic of voltaic cells, group projects are carried out by choosing their own types of assignments according to the interests and learning styles of students with activities of making chemical songs, simple practicum, limited webinars and advertisements for voltaic cell products. On the topic of electrolysis cells, a group project was carried out with the concept of combining economics/business into electrochemistry, called ecolectrochemistry. The voltaic cell project assessment uses five parameters: the accuracy of the voltaic cell concept, the relevance of the voltaic cell concept to the concept raised, creativity, fulfillment of task requirements, and collaboration. The ecolectrochemistry project assesses problem-solving skills using the IDEALS model, presentation assessment and assessment of creative and disciplined attitudes. The active and enthusiastic involvement of students is better than in the organic chemistry series. There is an increase in interest in learning chemistry from 27.38% to 65.48% and there is an increase in the average learning outcomes of the physical chemistry learning series compared to the organic chemistry learning series. These results indicate that learning designed according to students'.

INTRODUCTION

The pandemic period presents its own challenges for teachers to conduct chemistry lessons in virtual classrooms. Changes in the national exam policy also contributed to the reduced interest of class XII IPA students to study chemistry. Not to mention, the varied backgrounds and career goals in a study group make the teacher perform various learning techniques so that all students can be actively involved and master the learning provided. Preparing students according to their multidisciplinary career interests and 21st century demands is a challenge in designing a chemistry course (Kerr & Runquist, 2005). Scientific and educational organizations recommend that efforts to attract students' interest in STEM majors and careers begin at the secondary school level, when students develop their own interests and recognize their academic strengths (Kier et al., 2014). One of the implementations of career academies is the opportunity for students to be involved in performance-based learning (Castellano et al., 2017).

Pontianak Saint Peter's Catholic High School applies an independent curriculum in learning during this pandemic. The teaching materials given to class XII-natural science in the odd semester of 2020 are divided into two learning series, namely the organic chemistry series (benzene and its derivatives, alkane derivatives, polymers and macromolecules) and the physical chemistry series (redox reactions, voltaic cells, electrolysis cells and their stroichiometry). Considerations for the preparation of this material are the sustainability and ease of material as well as the use of teaching tools/media that are more familiar to students.

Teaching organic chemistry in Rwandan secondary schools uses a different approach, including group discussions, practical work, individual and group research and field trips (Iyamuremye et al., 2021). Prior to the pandemic, Santu Petrus Catholic High School had implemented a hybrid learning system with a Google Classroom-based Learning Management System platform in the @smapetrus.net domain. Class XII students are familiar with the form of information technology-based assignments and learning. Learning from the experience of the previous 2019-2020 even semesters, the learning method is designed in such a way as to overcome the main obstacles faced by students such as network availability, devices owned, and online learning timings (teleconferencing, tutoring, and assignments).

In this odd semester, students of class XII-natural science study chemistry (for theory and practicum classes) for 6x40 minutes in one learning day. The goal is that all activities and assignments can be completed in one day. A virtual meeting was conducted with Google Meet which was attended by 2 classes simultaneously (84 people in total). Learning is divided into several activities and varies every day with virtual meeting agendas, assignments, and virtual practicums. As students learn how to solve science problems conducting experiments, they can also learn how these activities and careers involve collaborative processes or contribute to humanitarian causes (Fuesting et al., 2017).

In the organic chemistry learning series, the types of learning activities carried out mostly use the ChemDraw application (for Laptop/PC), KingDraw (for android), or Whiteboard.fi (for quizzes) to draw the shape of organic molecules with the POE learning model (predict, observe, explain) modified (White, R. & Gunstone, 1992; Karamustafaoğlu & Mamlok-Naaman, 2015). Learners get material in learning videos, virtual discussions, and assignments given. Then they were asked to predict the molecular structure based on the material they understand by describing it in ChemDraw/KingDraw. The molecular structure is validated by the system (clean up) to find out whether the structure is correct or the name is correct. The results of the validation were observed and analyzed for the location of the discrepancy. Then students explain the results of their analysis in the worksheet provided. The virtual practicum that was carried out combined the use of ChemDraw/KingDraw with several virtual laboratories that were accessed online. In a study of human-computer interaction, including technology-assisted instruction, the focus is on virtual reality technology because of its ability to support immersive learning, teaching through simulation, and gamification of learning. These systems can provide a high-level multisensory learning experience that is essential in teaching many subjects, especially those involving abstract concepts or requiring spatial skills, such as organic chemistry (Edwards et al., 2019). The objective of studying organic chemistry is to acquire the knowledge necessary for a competent evaluation of structure-properties relationships, as well as to carry out independent manipulations (transformations) of “new structures” both on paper and in bottles. For this reason, it is expected to be able to classify structures and reactions (Beletskaya et al., 2017).

The learning outcomes for this organic chemistry series were 76 out of 84 students scored 75. However, after the diagnosis was made, as many as 73 students admitted to having difficulties with this learning method. Generally they admit that they still complete the assigned tasks to get good grades. This is further strengthened by a survey of interest in chemistry where only 23 people experienced an increase in interest in learning chemistry.

After analyzing the learning method, as many as 53 students stated that they could follow the information technology-based learning process and the problem-based assignments given. Subsequent investigations were carried out on the interests and career goals of the students. It was surprising that 51 people have a career interest in technology-based business/economics, the rest in the arts, culinary, engineering, and health fields. The form of learning activities which he judged was not related to their career interests reduced their interest in learning chemistry. This finding shows that the students' career interests have contributed to their chemistry learning difficulties and interests, even though they can follow the lesson and achieve learning mastery. Based on the chronological presentation above, The problem raised in this study is how to design chemistry learning in accordance with the career interests of students so that there is an increase in interest in learning chemistry? In this case, the career interests of students are considered to have a general tendency to economics/business and the topic of study in the physical chemistry learning series (voltaic cells and electrolytic cells).

This study aims to increase interest in learning chemistry by innovating chemistry learning that is oriented to students' career interests, especially in the economic/business field. This innovation is also expected to be a reference for the development of better learning for other chemistry topics. It is hoped that this innovation will provide insight for educators to design classroom learning that can facilitate students' career interests.

METHODS

Context and participant

The focus of the problem in this study is the decrease in interest in learning chemistry due to the incompatibility of learning with the career interests of students. Based on the problems found, the authors made changes in the learning design for the physics chemistry series into project-based learning oriented to the interests of the students, especially those related to economics/business. The learning carried out will be much in providing opportunities for students to choose how they want to be assessed. There were 84 students from XII-natural science grade participating in this study (these originated from two class, in Meet mode becoming one room but in class activity they conducted in their own class). SMA Santu Petrus system for chemistry class was conducted by co-teaching model where the class is handled by two teachers. One teach-one support model was used in virtual meeting/synchronous mode and station teaching model was used in asynchronous mode (Friend & Bursuck, 2012).

Procedure

Based on the analysis of the organic chemistry learning series, several changes were made to learning activities that could attract students' interest in learning chemistry. Virtual laboratory methods, problem-based assignments and virtual discussions are still being carried out. Innovation is carried out by designing projects that combine their field of career interest for voltaic cells and electrolytic cells. An introduction to redox reactions and identification of the two electrochemical cells was provided prior to project assignment. Table 1 describes the planning of learning innovations that will be carried out.

The voltaic cell projects have four option namely: (1) making a chemical song to summarize the voltaic cell material, (2) making a simple practicum on voltaic cell design, (3) conducting a limited webinar about voltaic cells, and (4) making an advertisement for voltaic cell products. Every student just must be involved in a team with a single option project. Every team is limited in its member total based on the complexity and the role in each project optioned (the criteria of each project are shown in Table 2). Each team must send a progress report in a monitoring form given. This monitoring report was used by the teacher to detect the collaboration and problems faced by each team. The first monitoring report identified the team members, the optioned project, the specific topic or what the activity will be conducted, and the role/job description of each member in the team. The second monitoring report to send the link of GDoc, GSlide, or note about the project design. The third monitoring report detected the problems they faced. The fourth monitoring report checked the video based on the criteria and sent the link of the project video. The last monitoring project was a self-assessment for each member.

In the first two hours, students were seeking for their teams by themselves (this was conducted to find the best collaboration team) and they were discussing and determining the project option. The second two hours, they formulated a project design (planning) by G-Doc or G-Slide. Based on this design, the teacher will validate for approving. Then, they had 2 hours to prepare or make the project. The products of their projects were made in video form.

Table 1. Learning Innovation Plans Oriented Career Interests of Students

Time	Content	Activity
week-1	Redox reactions, oxidation states and balancing redox reactions	Teleconferencing (*GMeet*), exercise example of group questions on GSlide
week-2	Reaction equalization exercise redox (team and individual)	Discussion Problems (*GMeet*), Value taking
week-3	Spontaneity of reactions and virtual practicum for designing row electrochemistry	Redox equalization application and online group practicum (LKPD via GDocs) with virtual laboratory
Week-4	Voltaic cells and practicum virtual	Literacy (*GSites*), Teleconference (GMeet), voltaic cell practicum
week-5	Monitoring 1and 2 (Design) Voltaic Cell Project	Design the voltaic cell project accordingly interest groups, as well as guidance, project revision and validation
week-6	Monitoring 3, 4, and 5 (Creation) Project Cell Volta	Product manufacturing guidance, solving problems encountered (via GClassroom, Whatsapp)
week-7	Comparison of Voltaic and Cells Electrolysis Cell	Project Collection, Literacy (GSites), Teleconferencing (GMeet)
week-8	Design Chemical Project Ecolectrochemistry	Designing a Metallurgical Company in chemical review
week-9	Business Design:Project Ecolectrochemistry	Company business revision and design metallurgy and presentation
week-10	Electrochemical Cell Exercise Group and Individual	Group practice, Discussion Question (GMeet), individual test

Table 2. Criteria for each project option

Criteria	Advertisement	Song	Practice	Webinar
Member	3-10 students	3-10 students	3-10 students	5-10 students
Design	Make a product promotion (application of voltaic cell	Make a chemistry song lyrics based on the voltaic cell concept.	Make a list of material, (in a simple and affordable thing).	The role of presenter, moderator, and

Criteria	Advertisement	Song	Practice	Webinar
	concepts): introduction, explanation, and persuasive campaign for green chemistry	How to sing, the music, tone, adopt/modified or make something new.	) procedure to prepare and test the product. How to explain the finding.	audience. Material for presentation is about the application of voltaic cell.
Report	Video in 3-5 minutes, the physical meeting is forbidden, and every person job should be documented in the video.	Video in 3-5 minutes, the physical meeting is forbidden, and every person job should be documented in the video.	Video in 5-7 minutes, the physical meeting is forbidden, and every person job should be documented in the video.	Video in 15-20 minutes, G-Meet recordings, and every person job should be documented in the video.

For the electrolytic cell project, the learning activity was designing a business plan called ecolectrochemistry project. There are seven problem topics that are given to be developed as a company, namely: (1) anti-rust keychain, (2) anti-rust roof, (3) oxygen gas from wastewater, (4) chlorine-free water, (5) lead-free water, (6) gold from polluted quarried lakes, and (7) aluminum from alum. Table 3 shows the stimulus for each topic. On the first meeting (week 7), students were discussing about the comparison between voltaic and electrolytic cells including the reaction and Faraday laws for the stoichiometry. In the week 8, the students were in new groups (6-7 members) discussing the stimulus given to develop a business plan. They should design the production process, materials needed, predicting the price (they should design the minimum mass/volume should be produced in order to get profit from their business).

Table 3. Stimulus for business plan designs in ecolectrochemistry projects

Topic	Stimulus
Anti-rust keychain	Your team wants to produce copper-plated iron keychains by the electrolysis method. Design the production process (tools, materials, electrolysis cell schematic, reactions at the anode-cathodes, electric current, time, calculation of the mass of copper coated on a keychain). Look for the reference price for the raw materials you use and then predict the price of the key chains that you will sell.
Anti-rust roof	Your team wants to produce a tin roof coated with metal that is rust-resistant by the electrolysis method. Design the production process (tools, materials, electrolysis cell schematic, reaction at the anode-cathode, electric current, time, calculation of the mass of the metal coated to the zinc). Look for the reference price for the raw materials you use, then predict the price of the stainless steel roof that you will sell.
Oxygen gas from wastewater	Your team wants to produce oxygen gas from sewer water by electrolysis method. Design the production process (tools, materials, electrolysis cell schematic, reactions at the anode-cathode, electric current, time, calculation of the volume of oxygen gas produced). Look for the reference price for the raw materials you use then predict the price of 1 oxygen gas cylinder that you will sell.
Chlorine-free water	Your team wants to produce chlorine-free water from river water by the electrolysis method. Design the production process (tools, materials, electrolysis cell schematic, reactions at the anodes-cathodes, electric current, time, calculation of the volume of chlorine gas released). Look for the reference price for the raw materials you use then predict the price of chlorine-free water that you will sell.
Lead-free water	Your team wants to produce clean water from river water which is known to be polluted by Pb^{2+} ions by the electrolysis method. Design the production process (tools, materials, electrolysis cell schematic, reactions at the anodes-cathodes, electric current, time, calculation of the mass of precipitated lead metal). Look for the reference price for the raw materials you use then predict the price of clean water that you will sell.
Gold from polluted quarried lakes	Your team wants to produce gold from lake water that was excavated from a gold mine containing Au^{3+} ions by the electrolysis method. Design the production process (tools, materials, electrolysis cell schematic, reactions at the anodes, electric currents, time, calculation of the mass of gold that can precipitate). Look for the reference price for the raw materials you use then predict the price of gold that you will sell.

Topic	Stimulus
Aluminum from alum	Your team wants to produce aluminum from alum $Al_2(SO_4)_3$. Design the production process (tools, materials, electrolysis cell schematic, reactions at the anodes, electric currents, time, calculation of the mass of aluminum that can precipitate). Look for the reference price for the raw materials you use then predict the price of aluminum that you will sell.

Instrument and Assessment

The assessment in voltaic cell project used a special rubric as shown in Table 4. In ecolectrochemistry project there are four assessments used they are the problem solving skill, the creativity, the discipline attitude, and the presentation skill. Problem solving skills are observed by modification of IDEALS method (Moutos, Okamoto, & Rhee, 2004) as shown in Table 5. Presentation assessment uses the presentation assessment aspect of Van Ginkel et al. (2017) which was modified according to presentation activities. The assessment of creative attitudes uses aspects of product creativity from Cropley & Cropley (2000), while the assessment of discipline uses aspects of the academic discipline scale of Jung et al. (2017). The indicators of the presentation, creative and discipline attitude can be seen on Table 6.

Table 4. Rubric for assessing the voltaic cell project.

Indicator	Minimum score criteria (1)	Maximum score criteria (4)
Accuracy of electrochemical concepts	The wrong concept detected during the project validation is not fixed	Right concept
The relationship of the concept of chemistry with another concept	There is no direct relationship with chemistry	The concepts raised are related to the voltaic cell and precise analysis
Creativity	>75% plagiarism (of the total video) without citing the source	<10% plagiarism (of the total video), modifications still include the source and can be declared a new work
Meet the requirements of the task	Not timely in conducting project validation, project implementation, and collection	Timely in conducting project validation, project implementation, and collection
Collaboration	No division of labor	All identified teams involved in project creation

Table 5. Indicators for assessing problem solving skills based on IDEALS method

Variable	No	Statements
Identify the problem	1	Recognizing similar problem models
	2	Write down the important points of the given problem.
	3	Determine the target to be completed
Define the context	4	Thinking of possible strategies to do
	5	Knowing how to organize the strategy you think about
	6	Determine the assumptions that support the problem-solving steps
Enumerate the choice	7	Develop a problem-solving strategy plan into sub-problems
	8	Compile chemical equations related to electrolytic cells
Analyze options	9	Analyze the components in a chemical equation
	10	Using other knowledge to solve problems
	11	Analyzing quantitative aspects
List reasons explicitly	12	Manage time effectively
	13	Determine the correct assumptions
Self-correct	14	Check that the method used is correct.
	15	Thinking there are other ways to solve the problem

Table 6. The indicators of the presentation, creative and discipline attitude

Aspek	Parameter	No	Activity
Creativity	Productivity	C1	make products with complete components
	Novelty	C2	make products with functional modifications in certain parts
	Distinctiveness	C3	make products with different models with examples.
Discipline	Consistent	D1	work hard consistently in project completion
	Complete	D2	complete the project.
	Efficient	D3	work on projects efficiently (do not waste time)
	Procedural	D4	work on projects with a sequence of work procedures that have been designed
	Be careful	D5	work on every detail of product components carefully.
Presentation	Appearance	P1	The presentation slide show is attractive and not bulky
	Articulation	P2	The presenter's voice is heard clearly
	Answer question	P3	Answer questions with logical ideas to convince the chemist
	Mastery material	P4	Can develop the points shown in the presentation
	persuasive	P5	How to convince investors to agree to the company's proposal

Data Analysis

A descriptive statistic used in this analysis. The data from the voltaic cell projects were converted into percentage to the total of selecting team for each option. The data from problem solving observation, creativity and discipline attitudes, and presentation skill observations were established as the average of all students based on each indicator.

RESULTS AND DISCUSSION

Voltaic Cell Project

Before giving the voltaic cell project, a meeting was held to discuss the voltaic cell material to the use of a virtual laboratory to simulate the voltaic cell. Then a group project is carried out by choosing the type of task given according to the interests and learning styles of students. In this project, students are free to choose their own team members.

There are four project options given, namely: (1) making a chemical song to summarize the voltaic cell material, (2) making a simple practicum on voltaic cell design, (3) conducting a limited webinar about voltaic cells, and (4) making an advertisement for voltaic cell products. . Each choice is given criteria that must be met. Students are given two weeks to prepare for the project and are asked to do monitoring and guidance via Classroom or Whatsapp. Revisions are made in the process of guidance and project creation. Products or experiments can be carried out when the design has been approved by the teacher. All products are documented and collected in the form of videos in the third week.

The selection of interest in the voltaic cell project from two classes (84 students) formed 18 teams consisting of 3 voltaic cell chemistry song teams, 4 voltaic cell product advertisement teams, 9 simple voltaic cell design practicum teams, and 2 voltaic cell webinar teams. Achievement (score 4) for each assessment parameter is shown in Table 7. Based on Table 7, the advertising specialization team did not master the voltaic cell concept in the project they were working on. The song specialization team tends to find it difficult to relate the concepts of voltaic cells to make proper lyrics and tends to plagiarize with existing songs. The practical team and webinars are still weak in analyzing the concept of voltaic cells in their products. Some of the notes given during group guidance did not become a reference for each team in the implementation or analysis of the experiment. These results indicate that project guidance needs to be carried out up to the analysis stage of report preparation. This is the basis for revising the problem boundaries in the ecolectrochemistry project so that the analysis process is more focused and in-depth.

Table 7. Achievement of Each Parameter of the Volta Cell Project

Parameter	Advertisement	Song	Practice	Webinar
Accuracy of electrochemical concepts	75.0%	91.7%	77.8%	87.5%
The relationship of the concept of chemistry with another concept raised	87.5%	83.3%	97.2%	100%
Creativity	93.8%	75.0%	86.1%	100%
Meet the requirements of the task	93.8%	91.7%	97.2%	100%
Collaboration	100%	100%	97.2%	100%

There were several obstacles encountered in the implementation of the project. First, giving students the freedom to choose their own team members causes some to not get a group so that in the ecolectrochemistry project the division of teams is regulated by the teacher. However, it should be noted again whether in each team there are students who have devices that can be used for presentations. Based on the experience experienced in learning in the organic chemistry series, there are students whose devices have problems so that they have difficulty opening GSlide or sharing screens during virtual meetings. Second, giving students the freedom to find solutions to open problems causes variety and breadth of discussion. In addition, there are difficulties in guiding, especially during the current pandemic. The most widely used guidance model is in writing via chat messages on GSlide or Whatsapp, while guidance with GMeet is only done when revising and conveying problem boundaries in general. Third, because the learning time is done at the same time for both classes, it is a bit difficult to arrange the presentation time. It is recommended that when applying this, the sequence of activities is adjusted to the learning hours. At the presentation stage, this is done during practicum hours using the co-teaching method (two teachers) so that problems can be handled. The last, limitation of analysis has the potential to reduce the creativity of the team in solving problems. Therefore, it is sufficient to limit the important aspects of the analysis only.

Ecolectrochemistry Project

Like the voltaic cell project, this project was preceded by a discussion of electrolytic cells. In the case of electrolysis cells, group projects are carried out with the concept of combining economics/business into electrochemistry, which is called ecolectrochemistry. Provision of introductory material is also carried out before the project is given. Based on the evaluation on the voltaic cell project, each group was randomly assigned by the teacher. Each group designs a company that will produce goods by applying the concepts of electrolysis and stoichiometry.

There are seven problem topics that are given to be developed as a company, namely: (1) anti-rust keychain, (2) anti-rust roof, (3) oxygen gas from wastewater, (4) chlorine-free water, (5) lead-free water, (6) gold from polluted quarried lakes, and (7) aluminum from alum. In the first week they designed their own chemical methods for production according to the topics given through GSlide. The results of the independent design were analyzed in terms of problem-solving skills using the IDEALS method (Mourtos, Okamoto, & Rhee, 2004) adapted to learning activities, then made some changes to the rules in team work.

After going through revisions and group guidance, in the following week certain boundaries were given for each problem topic so that the analysis was simpler. In addition, the group was merged into 3 teams according to the similarity of concepts to make it easier to guide. The fused results are called team A (topics 1 and 2), team B (topics 3, 4, and 5), and team C (topics 6 and 7). Then, they formulate a production scheme, tools and materials, a draft budget for the company's capital costs, and a simulation of its production and sales in order to make a profit in the production. Next, the company's designs are presented virtually to teachers who act as chemists and investors.

Presentations are only made by large teams and teachers in a maximum of 20 minutes via GMeet. In the presentation, each team demonstrated a predictive flow of tools and production schemes with the concept of electrolysis cells and predictions of material costs to be used based on stoichiometric analysis. In addition, they must act like a marketing team to lure investors into investing in their company designs.

The results of the achievement of problem-solving skills in independent design and designs given analytical limits can be seen in Table 8. Based on Table 8, students have difficulty in defining the context of the problem and registering the reasons for the completion. Specifically, this occurs in the formulation of the basic assumptions used to perform stoichiometric analysis with Faraday's Law in the design of materials. This is the basis for giving problem limits and asking students to make basic assumptions of electrolysis before carrying out calculations to determine the amount of material needed. The result is that all indicators reach the maximum in the design that has been given the analysis limit. This design-based learning impacts to awareness and interest of students in learning (Reynolds, Mehalik, Lovell, & Schunn, 2009). They promote the identification of the problem and self-correct in their problem solving activities.

Table 8. Achievements in Troubleshooting Ecolectrochemical Projects

Indicator Design	Identify the problem	Define the context	Enumerate the choice	Analyze options	List reasons explicitly	Self-correct
independent	95.2%	69.0%	89.3%	76.2%	42.8%	96.4%
Restricted	100%	100%	100%	100%	100%	100%

Table 9 informs the achievements in presentation skills and attitudes during group project work. Some teams show great interest when promoting the company in presentations so the delivery style is very persuasive. However, the effect of limiting the analysis is a decrease in creativity in modifying the solution. The systematic presentation of the material presented is generally the same as that stated in the description of the analysis limits. Even so, the discipline of students completing the project within the set time limit increases because the goal of completion becomes clearer after the completion of the completion limit.

Table 9. Achievement of Presentation Ability, Creative Attitude and Discipline

Criteria Presentation	% Achievements	Criteria Creative	% Achievements	Criteria Discipline	% Achievements
Appearance	100	Productivity	100	Consistent	69.0
Articulation	100	Novelty	66.7	Complete	100
Answer question	92.9			Efficient	100
Mastery material	100	Distinctiveness	71.4	Procedural	100
persuasive	71.4			Be careful	88.1
average	92.9	Average	79.4	Average	91.4

Interest, Involvement, and Learning Outcomes of Students

In practice, the active and enthusiastic involvement of students is better than in the organic chemistry series. In addition, there was an increase in interest in learning chemistry as 55 out of 84 students admitted that they were more interested in learning chemistry (increase in interest from 27.38% to 65.48%). This is in line with 60 students who feel they can follow the lesson and understand the material even though there are still doubts about their understanding. These results indicate that learning designed according to students' career interests can increase interest and achievement in learning chemistry. The comparison of the increase in learning achievement between the organic chemistry series and the physical chemistry series can be seen in Figure 1.

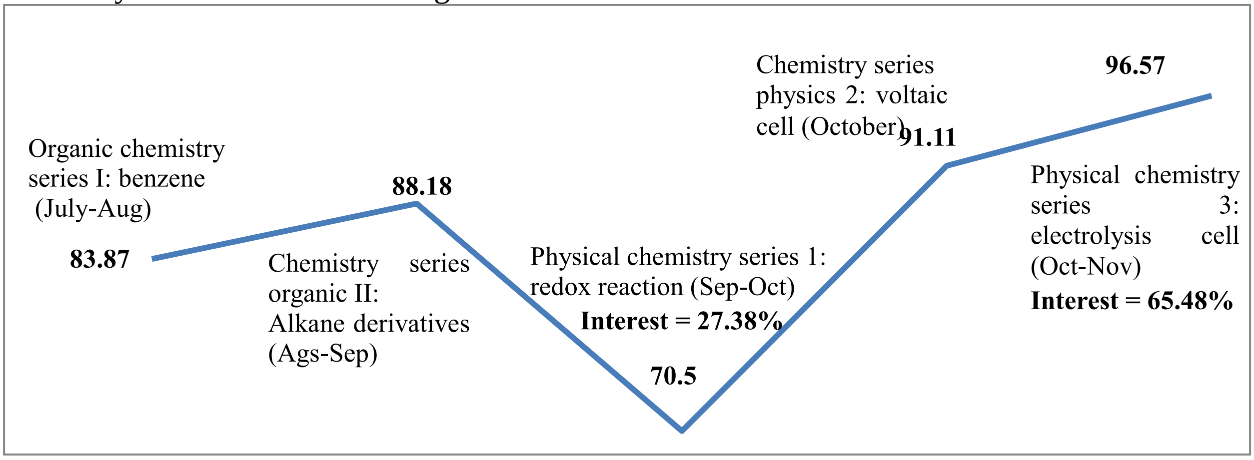

Figure 1: The Development of Average Grades Per Class XII Chemistry Learning Series Odd Semester 2020 (Online System)

Based on the results and evaluation of this innovation, the design of learning oriented to the career interests of students will be continued for the topic of chemistry learning in class X and XI to foster interest in learning chemistry at a higher level. Non-cognitive diagnosis of learning needs will also continue to be developed to see other factors that hinder students' interest in learning. In addition, chemistry problem-solving activities will also be developed that can still develop creativity and are in accordance with students' learning styles, and can even lead to collaborative learning with various subjects such as integrative type STEM (science, technology, engineering, and mathematics).

This learning process is expected as the stimulus for students to love and increase their interest in STEM field for their future career (Beier et al., 2019). The educators should aware their students who may not conceptualize science, technology, engineering, and mathematics as a unified area, further supporting the domain-specific nature of educational and career interest in high school students (Oh et al., 2013). Currently, it is important to pay attention to the affective and social needs of their higher education and their career rather than assuming that students at this stage can maintain their own interest and motivation (Hazari et al., 2010). Students may not develop a strong interest in science and mathematics simply since they have not been exposed to these disciplines in such a manner that engages and encourages their interest (Dabney et al., 2012).

Seeking the relation between a topic and a career to find every student's interests is hard and consuming more time. Career-related instruction should be designed on emphasizing the perceived personal value and relevance of careers for the student (Salonen et al., 2018). In general, a person usually chooses occupations in those areas where he/she can prove related skills and capacity. As the builder of his/her own future, an individu must choose the career related to the knowledge and desire. A scientific career needs particular skills and a positive attitude related to all scientific issues (Gorghiu & Santi, 2017).

CONCLUSION

Based on the results and evaluation of the chemistry learning innovation in the physical chemistry series, learning that is in accordance with the students' career interests in economics/business in the voltaic cell and electrolytic cell physics chemistry series can be done by combining business design with an electrochemical group project called ecolectrochemistry. In its application, the selection of groups must be controlled by the teacher, and analysis limits are given to clarify the completion targets but do not hinder the creativity of students. Through learning multidisciplinary chemistry projects according to their career interests, these students can increase their achievement and interest in learning chemistry.

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