Available online at http://journal.um.ac.id/index.php/jps/
ISSN: 2338-9117/EISSN: 2442-3904

Jurnal Pendidikan Sains
Volume 6, Number 1, March 2018, pp. 23–29

College Students Understanding on Spectroscopy Topic Using STAD Cooperative Learning Combined with Moodle

Ade Trisnawati, Surjani Wonorahardjo, Munzil Arief
Chemistry Education–Universitas Negeri Malang
Jl. Semarang 5 Malang, Indonesia 65145. E-mail: adetrisnawati14@gmail.com

Abstract: Spectroscopy is an abstract and difficult topic in chemistry. Students should be able to explain this concept. The purpose of this pre-experimental research was to explore the understanding of students about spectroscopy using STAD cooperative learning combined with Moodle. A sample of this study were 34 fifth-semester college students majoring at Chemistry studying at the University X. The results showed the students' understanding on tools instrumentation and their functions on Raman spectroscopy, photometric titration method, the function of the components in IR spectrophotometer, compounds based on transition-absorbing electrons, and the basic principle of atomic spectroscopy material were low.

Key Words: students' understanding of spectroscopy concept, STAD cooperative learning, moodle

Abstrak: Spektroskopi merupakan salah satu materi yang bersifat abstrak dan sulit. Mahasiswa harus mampu menjelaskan konsep tersebut dengan baik. Penelitian pra-eksperimental ini bertujuan untuk menggali pemahaman materi spektroskopi mahasiswa pada pembelajaran kooperatif STAD yang dipadu dengan Moodle. Sampel penelitian adalah mahasiswa program Pendidikan Kimia Universitas X semester 5 yang berjumlah 34 mahasiswa. Hasil penelitian menunjukkan bahwa pemahaman mahasiswa pada alat-alat instrumentasi pada spektroskopi Raman beserta fungsinya, metode titrasi fotometrik, fungsi komponen-komponen dalam spektrofotometer IR, macam-macam senyawa penyerap berdasarkan transisi elektronnya, dan prinsip dasar materi spektroskopi atom tergolong rendah.

Kata kunci: pemahaman mahasiswa pada materi spektroskopi, pembelajaran kooperatif STAD, moodle

INTRODUCTION

Spectroscopy is a topic that provides information regarding a sample through the interaction between matter and radiation (Skoog et al, 2014). Spectroscopic methods can be distinguished based on the form of material interactions with light, such as the absorption of light on ultraviolet-visible spectroscopy, light scattering in Raman spectroscopy, light emission in emission spectroscopy and light fluorescence in atomic fluorescence spectroscopy. Knowledge of the basic principles of spectroscopic methods is very important to be mastered by students, particularly in the field of chemical analysis.

Spectroscopy is considered as one of the abstract and difficult chemistry topics. Frequently, students find it difficult to imagine the process of absorption, emission, scaterring or light fluorescent. Consequently, students cannot easily understand the basic concept of every spectroscopy method and cannot distinguish one method to another. It is further supported by the interview results conducted to Chemistry students at University X Academic Year 2012/2013. Otto, et. al., (2005) also confirm that after a year of learning, students still have an inadequate understanding regarding the basic concept of spectroscopy. Carbo et. al., (2010) even justify that spectroscopy is a black box which is difficult to understand.

Therefore, according to the issue encountered by students as explained before, it requires learning development on Chemistry lesson for instrument analysis, particularly spectroscopy topic which deal with extensive knowledge construction. The development is important in order to assist students to be able to understand the basic concept and avoid any fallacy and misconception. Information technology develop-

Article received 13/11/2017; Approved 24/2/2018

ment is expected to provide accessibility and benefit in obtaining extensive and varied information of spectroscopy topic as an expandable method.

Hence, to resolve the above-mentioned issue, this study applied Cooperative Learning STAD combined with Moodle. During the learning, computer technology such as animation, video, or any interactive media will be used to explain the abstract concept of spectroscopy. Interactive media offers a better presentation for students in understanding the concept than static figure (Chasteen, 2007). Further, to habituate students in understanding important terms, question-answer session, exercising sesssion, and discussion with group lesson could be employed. Group lesson is beneficial for students to help to memorize and to discuss the topics. It encourages a discussion and interaction among students with different level of understanding which improve their confidence in solving the complex problem due to support from group members (Ross & Fulton, 1994). In addition, moodle provides continous discussion through online learning platform. Therefore, this study aims at obtaining students' understanding of spectroscopy topic using STAD Cooperative learning combined with Moodle.

METHOD

This study employed pre-experimental design. The pre-experimental design was employed since it aimed at giving certain treatment to subject in order to obtain and identify the effect (Fraenkel & Wallen, 2009). The data were obtained through 45 items of multiple choices objective test with five options and quizz results as supported data. It took 34 students of Fifth Semester Chemistry Education Department at University X as research sample. It employed a convenience sampling technique. Before being used as a research instrument, the items were verified by employing content validity test, difficulty index of the test item, difference index of the test item, item validity, and content reliability.

During data collection, it began with the prerartion of learning and cntinued with the implementation of STAD Cooperative learning combined with Moodle. It was carried out six meetings. The first and second meetings were discussing UV-VIS Spectroscopy, the third and fourth meetings were discussing infrared spectroscopy, the fourth meeting was discussing Raman spectroscopy, the fifth and sixth meetings were discussing atomic spectroscopy. One cycle of the meeting was arranged as follows: preliminary assignment (online), classroom presentation phase (face-to-face), discussion (both face-to-face and online), quiz (face-to-face or online), team scoring progress and recognition (face-to-face) (Trisnawati, 2016). Furthermore, it was continued by providing comprehension test.

To analyze the obtained data, the descriptive statistic was employed. It was conducted by giving a score, tabulating data, and calculating the data. It calculated students undersatnding determination in each learning indicator of spectroscopy topic by comparing the number of students who provided the right answer to the entire number of students.

RESULTS

Students Understanding on UV-VIS Spectroscopy Topic

Students understanding percentage regarding UV-VIS Spectroscopy topic could be seen from the percentage of students who provided a correct answer during the test. It is showed in Table 1.

Students Understanding on Infrared Spectroscopy

Students understanding percentage regarding Infrared Spectroscopy topic could be seen from the percentage of students who provided a correct answer during the test. It is showed in Table 2.

Students Understanding on Raman Spectroscopy

Students understanding percentage regarding Raman Spectroscopy topic could be seen from the percentage of students who provided a correct answer during the test. It is showed in Table 3.

Students Understanding on Atomic Spectroscopy

Students understanding percentage regarding Atomic Spectroscopy topic could be seen from the percentage of students who provided a correct answer during the test. It is showed in Table 4.

Table 1. Students Understanding on UV-VIS Spectroscopy Topic Percentage

Aspect	Learning Indicator	Correct Answer Mean (%)
Basic Principle	Explaining the basic concept of absroption in the UV-Visible area	50,97
	Explaining the excitation of electrons as a result of energy absorption in the UV-Visible area	60,78
	Predicting the types of absorbent compounds based on their electron transitions	47,1
Instrumentation	Describing instrumentation of UV-VIS spectrophotometer and its components.	61,8
	Describing the use of components in a UV-VIS spectrophotometer.	97,1
	Explaining the types of UV-VIS spectrophotometers.	79,4
Application	Describing the application of UV-VIS spectrophotometry, analysis of an analyte substance and analysis of analyte mixtures.	85,3
	Describing the techniques for determining the concentration of analytes in ordinary calibration and addition standards.	76,5
	Describing photometric titration methods along with the terms of use as an application of UV-VIS spectrophotometry	32,4

Table 2. Students Understanding on Infrared Spectroscopy Percentage

Aspect	Learning Indicator	Correct Answer Mean (%)
Basic Principle	Explaining the principle of absorption in the infrared area and its requirements.	88,25
	Explaining the types of vibrations in a molecule.	91,2
Instrumentation	Mentioning components in IR Spectrophotometer	82,35
	Explaining components function in IR spectrophotometer	44,17
Application	Describing the functional group absorption area of a compound in the infrared spectrum.	72,05
	Explaining the application of infrared absorption methods in analytical chemistry.	70,60
	Explaining the limitations of infrared spectrophotometry methods.	64,70

Table 3. Students Understanding on Raman Spectroscopy Percentage

Aspect	Learning Indicator	Correct Answer Mean (%)
Basic Principle	Explaining the basic principles of Raman spectroscopy.	85,3
Instrumentation	Describing the instrumentation parts of the Raman spectrometer and its functions.	17,60
Application	Providing applications of Raman spectroscopic methods in chemical analysis.	79,40

Table 4. Students Understanding on Atomic Spectroscopy Percentage

Aspect	Learning Indicator	Correct Answer Mean (%)
Basic Principle	Explaining the main principles of atomic spectroscopy.	73,53
	Describing the basic principles of atomic absorption spectroscopy (AAS), atomic emission spectroscopy (SEA) and atomic fluorescence spectroscopy (SFA).	58,8
Instrumentation	Explaining in the main instrumentation chart of atomic spectroscopy	75
	Describing the instrumentation components of SSA, SEA and SFA and their functions.	91,2
Application	Explaining some of the interference in the measurement with the SSA method.	82,4
	Explaining some of the disturbances in the measurement with the SEA method.	67,6
	Understanding and calculating the concentration of analytes in samples with atomic absorption spectroscopy (AAS) and atomic emission spectroscopy (SEA) methods.	14,7; 91,2; 100

DISCUSSION

Students Understanding on UV-VIS Spectroscopy Topic

Ultarviolet-Visible Spectroscopy topic was offered to students in two meetings. The first meeting was conducted by having face-to-face learning to discuss the principle of the method. While to discuss instrumentations of UV-VIS Spectroscopy, online learning was conducted. The second meeting was conducted by both face-to-face and online to discuss UV-VIS Spectroscopy application (qualitative and quantitative analysis). According to Table 1, it is showed that only a few numbers of students have understood basic principle aspect regarding predicting kinds of absorption compounds based on its electron transition and application aspect regarding photometric titration method along with pre-requisite usage as the application of UV-VIS spectrophotometry. In addition, most of the students have understood the instrumentation aspect on components usage of UV-VIS spectrophotometer.

Difficulties encountered by students in learning basic principle and application are closely related with learning process conducted. Face-to-face learning was conducted to discuss the basic principle in the first meeting and UV-VIS spectroscopy application in the second meeting. According to observation results on STAD group in the first and second meeting, interaction and communication among students were not actively perceptible. Most of the students were still independently learning and during the presentation activity, it was dominated by some active students. Most passive students did not give their answer. According to the first quiz, most students have not understood yet the correlation of ultraviolet-visible light absorption process on compounds with bond types of certain compound and any type of electron which is responsible for light absorption. The obatined difficulty issue is the main reason why students cannot predict kinds of absorption compound based on electron transition. Further, the second meeting of quizz indicates that most of the students were difficult to understand the basic principle of titration of photometric and its dissimilarity to common acid base titration.

On the other hand, pretty much of students have sufficient understanding about UV-VIS spectrophotometer components, the usage, and the kinds. The topic understanding enhancement was done by employing online learning through Moodle media. The percentage is pretty much good since during the topic understanding ehnancement students used any kind of learning materials, both from the instructors and their own learning materials from the internet. Learning materials provided in Moodle are varied such as images, animations, videos, or websites containing a combination of learning materials. Students understanding about instrumentation highly influences conceptual understanding and attitude towards learning (Malina & Nakhleh, 2003). Furthermore, the discussion process in STAD Cooperative Learning combined with Moodle is observable though online discussion. In this case, the interaction and communication among students are perceptible. Some students have initiated discussion in group forum or classroom forum by providing an explanation, qustion, refutation to the idea, or providing additional information. The online discussion provides students more freedom and opportunities to question and understand the topic compared to the conventional face-to-face learning.

Students Understanding on Infrared Spectroscopy

According to the percentage in Table 2, students understanding on components function of infrared spectroscopy was still lesser (44.17%). On the other hand, most students have understood absorption principle in infrared are along with its pre-requisite and types of vibration on the certain molecule. Difficulties encountered by students in learning instrumentations of IR Spectroscopy method is closely related with learning process conducted. Online learning to discuss instrumentation method of IR spectroscopy was conducted in the third meeting. In the online platform, learning materials such as images, animations, and videos are provided. Nonetheless, students were still difficult to understand this topic. The findings indicated that students have less ability to distinguish and analyze the similarity and difference between IR and UV-VIS Spectrophotometer. For instance, from the test results, it is known that there are still many students who do not know that the location of the sample in the IR spectrophotometer is before the monochromator. It is different from the location of the sample on a UV-VIS spectrophotometer which is placed after the monochromator.

Students also do not understand the reason for the sample placed before the monochromator in an infrared spectrophotometer. In addition to the questions about the simple series of IR spectrophotometer devices, there are still many students who mention incorrectly the function of the chopper and monochromator.

Although online learning is not able to run optimally, it still has a positive influence on students where they can be responsible for the learning process, such as being actively involved in the discussion and willing to find or read the teaching material provided.

In understanding the basic principles, most students have understood the basic principles of absorption in the infrared area and the requirements and types of vibrations in a molecule. The acquisition process in this aspect can run optimally because the discussion does not only occur face-to-face but there is also an additional discussion on online learning. At face-to-face meetings, not all MFI materials can be resolved. Thus, additional discussion is required where the discussion is conducted online. Based on these additional discussions, it turns out there are still many students who do not understand compounds that can absorb infrared light, the characteristics, and the vibrations that occur when a compound absorbs infrared light. With this additional discussion, students are trained to work together and listen to peer's opinions to achieve an understanding of the submersion of the principle of spectroscopic methods. The final test results students confirm a good understanding of the principle aspects of infrared spectroscopy among students.

A good understanding of the principle of this method is also shown from the results of the quiz. Most students have understood that if a substance absorbs infrared radiation, the radiation energy will be converted into vibrational energy and rotational energy. The atoms in a molecule are dynamic, carrying out vibrational and rotational movements continuously. This vibration and rotation result in a change in the dipole moment on a regular basis which causes a field to interact with the electric field of electromagnetic waves. If the frequency of electromagnetic waves corresponds to the vibrational frequency of the molecule, the amplitude of the vibration of this molecule will increase sharply, so there will be infrared absorption (Budiasih, 1992).

Students' Understanding of Raman Spectroscopy

According to the percentage of students' understanding of Raman spectroscopy topic, it can be seen that only a small percentage of students have understood the aspect of Raman spectroscopic instrumentation (on the indicator of explaining the instrumentation parts of the Raman spectrometer and its functions). The learning process carried out was online learning at the fourth meeting. In online learning, teaching materials are available in the form of images, animation, and videos, and forums for discussion. Even so, students' understanding is very low on aspects of instrumentation. For instance, students are still difficult in understanding how the components are arranged in the Raman spectrometer even though they already know the components of the Raman spectrometer. For instance, it is assumed that before the Rayleigh scattering separation and Raman scattering have to be filtered, the scattering light of the stokes and anti-stokes will be incorrect. The correct explanation is before obtaining scattered stokes and anti-stokes, filtering Rayleigh scattering and Raman scattering by the sample illumination system and the light collector must be done. Then, by the wave coupling filter, the scattering is filtered repeatedly to obtain the scattering light and stokes and anti-stokes before the detector is captured.

Based on the above-mentioned explanation, it can be seen that online learning using Moodle cannot run optimally. In online discussions, student interaction and communication were less visible. Most activities were only asking the instructor without generating ideas discussion. In addition, a low understanding of this instrumentation aspect is due to the lack of teaching materials related to instrumentation tools in Raman spectroscopy methods. The characteristics of Raman spectroscopic material are classified as complicated and the most difficult topic. Consequently, students have less interest in the learning which the activities were only limited to asking a question instead of generating active discussion. In addition, students provided less respond to the peer's discussion or even did not respond at all. However, since this topic is classified as the most difficult topic, instructor's guidance is required. Face-to-face learning where students can meet directly with teachers and fellow students is very helpful for students in understanding the difficult material because they can directly ask what they do not know. Learning will be effective when students can face and justify their wrong perception (Wenzel, 2014). In addition to this face-to-face learning, students can work together by having active interaction process such as asking and discussing among them. In the end, students can improve their self-confidence and have the ability to overcome difficulties. It is confirmed by the results of research where the basic principles and applications implemented on face-to-face learning can provide a good understanding for students.

Students' Understanding of Atom Spectroscopy

Based on the percentage presented in Table 4, only a small percentage of students (14.7%) can understand and calculate the concentration of analytes in a sample with atomic absorption spectroscopy (AAS) and atomic emission spectroscopy (SEA). In addition, low student understanding also occurs in understanding the basic principles of atomic spectroscopy methods related to the different basic principles of atomic absorption spectroscopy (AAS), atomic emission spectroscopy (SEA) and atomic fluorescence spectroscopy (SFA) (58.8%). Additionally, most students already understand the related aspects of instrumentation on indicators explaining the instrumentation components of SSA, SEA and SFA and their functions (91.2%).

Low understanding of students on the basic principles of atomic spectroscopy methods occurs because students are unable to visualize the processes that occur in electrons which are the basis of atomic spectroscopy. Hence, students are difficult to imagine the principles. Besides, the difficulties of students in these aspects also occur because they have not been able to maximize the stages of learning. At the face-to-face learning, students are less able to maximize the group discussion and the is very limited in the teaching materials used for discussion. Unlike online learning, the acquisition of an understanding of instrumentation tools is supported by the use of animated videos with moodle that can help students observe what processes occur in spectroscopic methods. The existence of communication facilities using Moodle allows students to share information. The provision of complete and attractive learning facilities using moodle makes students retain their attention during the learning activities.

Overall, STAD Cooperative learning using Moodle is quite helpful for most students in providing an understanding of the spectroscopic topic. In other subjects, this learning model also has a positive impact on students. For instance, the research conducted by Sari (2015) which states that blended learning in STAD cooperative learning does not have a negative impact on Chemistry students when learning NMR topic. Students argue that STAD cooperative learning with blended learning is a fun learning and motivate them to learn and understand the topic. In addition to the organic chemistry course II, the results of research conducted by Purwanto (2015) shows that the application of blended learning in STAD cooperative models using moodle can improve the achievement and motivation of chemistry students in University X.

CONCLUSION

According to the above-explanation on findings and discussion, most students have relatively sufficient understanding of spectroscopy topic. It further affirms that STAD Cooperative learning using Moodle is effective to help students in improving their understanding on spectroscopy topic. Through this learning, students have extensive opportunity to share information, connect ideas, and discuss the topic which is not only limited to face-to-face learning in the classroom but also online learning. However, students' understanding on instrumentation of Raman Spectroscopy and its function, titration photometric method, the function of components in an IR spectrophotometer, predicting the types of absorbent compounds based on their electron transitions, and the basic principles of atomic spectroscopy material are insufficient.

Based on the results of the research the researchers offer the following suggestions. The results of the study can be used as information for teachers in providing reinforcement of the prerequisite concepts, including concepts in organic chemistry, basic chemistry related to electron excitation. In addition, research on the understanding of the spectroscopic topic can be followed up by developing appropriate and varied teaching materials to support the process of teaching and learning activities.

REFERENCES

Budiasih, E. (1992). *Analisis Instrumentasi Bagian I.* Malang: Institut Keguruan dan Ilmu Pendidikan Malang.

Carbo, A. D., Adelantado, J. V. G. & Reig, F. B. (2010). Black boxes in analytical chemistry: University student misconceptions of instrumental analysis. *US-China Education Review*, 7(7), 15–29.

Chasteen, T. G. (2007). *Web based Animation in Analytical Chemsitry*. Washington: American Chemical Society.

Fraenkel, J. R. & Wallen, N. E. (2009). *How to design and evaluate research in education 7th Edition.* New York: McGraw-Hill Companies.

Malina, E. G & Nakhleh, M. B. (2003). How student use scienctific Instruments to create understanding: CCD Spectrophotometers. *Journal of Chemical Education*, 80(6), 691–698.

Otto, W. H., Larive, C. K., Mason, S. L., Robinson, J. B., Heppert, J. A. & Ellis, J. D. (2005). Using visible spectrophotometers and pH measurement study speciation in a guided-inquiry laboratory. *Journal of Chemical Education*, 82(10), 1552–1554.

Purwanto, K. K. (2015). *Pengaruh Penerapan Blended Learning dalam Model Kooperatif STAD menggunakan moodle pada matakuliah Kimia Organik II terhadap Prestasi Belajar dan Motivasi Mahasiswa Jurusan Kimia Universitas Negeri Malang* (Unpublished master's thesis). Graduate school Universitas Negeri Malang, Malang, Indonesia.

Ross, M. R., & Fulton, R. B. (1994). Active Learning Strategies in the Analytical Chemistry Classroom. *Journal of Chemical Education*, 71 (2), 141–143.

Sari, D. N. (2015). *Pengaruh Pembelajaran Kooperatif STAD dipadu dengan Blended Learning terhadap Hasil Belajar Kognitif Materi NMR Mahasiswa Jurusan Kimia Universitas Negeri Malang* (Unpublished master's thesis). Graduate school Universitas Negeri Malang, Malang, Indonesia.

Skoog. D. A., West, D. M., Holler, F. J. & Crouch, S. R. (2014). *Fundamental of Analytical Chemistry, Ninth Edition*. USA: Brooks/Cole, Cengage Learning.

Trisnawati, A., Wonorahardjo, S., & Arief, M. (2016, March). *Pembelajaran kooperatif STAD dipadu dengan Moodle pada Matakuliah Kimia Analisis Instrumentasi*. Paper presented at the meeting of Seminar Nasional II Biologi, Pembelajaran dan Lingkungan Hidup, Jurusan Biologi Universitas Muhammadiyah Malang, Malang, Indonesia.

Wenzel, T. J. (2014). Active learning materials for molecular and atomic spectroscopy. *Analytical and bioanalytical chemistry*, *406*(22), 5245–5248.