P-ISSN: 1693-1246
E-ISSN: 2355-3812
June 2021

Jurnal Pendidikan Fisika Indonesia 17 (1) (2021) 13-21
DOI: 10.15294/jpfi.v17i1.23969

http://journal.unnes.ac.id/nju/index.php/jpfi

E- Formative Assessment Integration in Collaborative Inquiry: A Strategy to Enhance Students' Conceptual Understanding in Static Fluid Concepts

S. Kusairi*, H. A. Hardiyana, P. Suwasono, A. Suryadi, Y. Afrieni

Department of Physics, Universitas Negeri Malang, Indonesia

Received: 06 January 2021. Accepted: 09 March 2021. Published: June 2021

Abstract

This study aims to analyze students' conceptual understanding and their difficulties in grasping the static fluid concepts after they learned throughout integrated e-formative assessments in collaborative inquiry. This mixed-method research involved 28 senior high school students. Students studied static fluid concepts with a collaborative inquiry strategy supported by the implementation of web-based formative assessment. Students' conceptual understanding and their difficulties were assessed using multiple-choice questions with the reasons (r= 0.75.). The result showed that students' conceptual understanding was improved after learning, which is indicated by the moderate normalized gain value (0.5374), and the strong effect size (2.772). However, there were still some difficulties that students have regarding factors that influence buoyancy. Providing more portion of the conceptual discussions and practising problem-solving during learning through e-formative assessment were recommended. Learning difficulties that have been found in this study can be considered and anticipated by teachers in teaching static fluid topic.

Keywords: collaborative inquiry, e-formative assessment, static fluid, student difficulties.

INTRODUCTION

The static fluid is a physics concept that is found in students' everyday life. In the secondary level, three basic topics are essential to learning the concept: hydrostatic pressure, Pascal's Law, and Archimedes' Principle. Many phenomena in everyday life can be explained by the static fluid concept (Sulasih et al., 2017). The buoyancy, blood pressure, and water transportation in plants are some examples of static fluid concept applications. Students can solve a problem related to static fluid based on the intuition and the experience they get in everyday life (Besson, 2004). Therefore, static fluid concept should be easily understood and mastered by students.

The previous study revealed that students still have some difficulties in learning the concept of static fluid (Kusairi et al., 2017). In a similar vein, Handayanto et al. (2018) also found that students often face conceptual difficulties when trying to solve static fluid problems, among others, in understanding the concept of total force acting on objects inside a fluid. Wagner et al. (2014) also found that students found it difficult to understand Archimedes' principles correctly. In addition, research conducted by Loverude et al. (2010) found that students experienced difficulties in the concept of force acting on objects in the fluid and connecting the force with the pressure concept. Students also have difficulties understanding the concept of hydrostatic pressure and what factors influence it (Goszewski et al., 2013).

The collaborative inquiry learning is an alternative of the inquiry learning model that has been the focus of research in recent years (Gijlers & de Jong, 2009; Raes et al., 2014; Urhahne et al., 2010) and has been predicted to improve students' conceptual understanding. Collaborative inquiry is a learning model that encourages students to learn

*Correspondence Address:
Jl. Semarang No. 5 Malang, 65145, Indonesia
E-mail: sentot.kusairi.fmipa@um.ac.id

independently and think critically through a scientific approach (Bell et al., 2010), and is suitable for application in science classes (Ucan & Webb, 2015), especially in physics learning. In a collaborative inquiry, students are expected to be able to explore and analyze various phenomena that are scientifically studied through the investigation process (including the formulation of problems and hypotheses, data collection and interpretation, and preparation of discussions) and then discuss them in groups to exchange ideas and knowledge. However, integrated e-assessment formative in the collaborative inquiry was not yet accomplished.

Despite this, learning needs to be supported by good assessments, including formative assessment (Bennett, 2011; Loughland & Kilpatrick, 2015). Formative assessment is an assessment carried out to facilitate student learning by giving feedback (Weurlander et al., 2012). Research had shown that formative assessment helps increase student motivation and achievement (Black & Wiliam, 1998; McMillan et al., 2013). In physics learning, formative assessment is also necessary to help students learn, given the characteristics of tiered physics subject matter (Kusairi, 2013). In practice, formative assessment requires quite a long time and is relatively complex. These problems, however, can be overcome by carrying out the process using the online computer technology or E-assessment assistance. Besides being able to overcome the problem of limitations in the implementation of formative assessments, the application of e-assessment can also increase student motivation in learning and support the improvement of the quality of learning in the classroom (Lafuente et al., 2014; Rodríguez-Gómez et al., 2016).

The purposes of this study are: (1) Analyzing students' conceptual understanding in fluid before and after learning with the integrated e-formative assessment in collaborative inquiry; and (2) identifying the difficulties that students have in the subject of static fluid after finishing the instruction process.

METHOD

This study is mixed-method research with the embedded design model. Quantitatively, the data collection on this current study was conducted by delivering a pre-test, giving treatment, and ending with a post-test. Simultaneously, the qualitative data were collected by analyzing the students' reasons when answering the questions. The research instrument used in this study was the concept understanding test. The subjects in this study were 28 grade XI students of one of the public high schools in Kota Malang, Indonesia.

The treatment provided in this study is in the form of learning activities using the Integrated e-formative assessment in collaborative inquiry learning. Learning activities are divided into three meetings where at each meeting different topics in the static fluid subject were discussed. At the first meeting, the learning activities were carried out to study the topic of hydrostatic pressure, at the second meeting studying Pascal's law, and at the third meeting learning about the principles of Archimedes.

In each meeting the learning activities carried out were based on the steps of collaborative inquiry learning. The learning activities consist of 6 phases described in the following diagram.

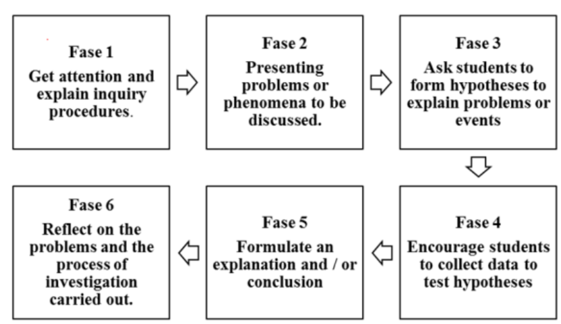


Figure 1. Learning steps of collaborative inquiry model

In learning with the collaborative inquiry model, students carry out investigative activities together (collaboration) in small groups, but each student still gets a worksheet even in one group. Students must write the results of their investigations on the worksheet even though the investigation process is carried out through group experiments and collaborative discussions.

In addition to using the collaborative inquiry learning model in this study, learning is also assisted with online class facilities on the e-learning.fmipa.um.ac.id website that can be accessed by students anytime and anywhere. The use of websites for online learning is a form of application of an e-formative assessment. On the website, there are diagnostic tests, discussion forums, learning videos, and formative questions that students can use to learn. Every time before the learning meeting is held, students are asked to do diagnostic tests that students can use to determine what material should be prepared for classroom learning.

The questions used in this study were adapted from the questions used in the research conducted by Wagner et al. (2014); Goszewski et al. (2013); and Rahmawati et al. (2018). Through the instrument, two types of data were obtained, namely quantitative data in the form of understanding concept values and qualitative data in the form of reasons for student’s answers that illustrate students' conceptual understanding. Presented in Table 1 below are indicator and the test item numbers used in the conceptual understanding instrument.

Quantitative data obtained from student’s concept understanding tests were used to analyze concepts before and after learning using the integrated e-formative assessment collaborative inquiry model. Using quantitative data, Normalize Gain that illustrates the increase in students' conceptual understanding from pre-test to post-test can be calculated. In addition, it also calculated the impact strength of the treatment given to students' conceptual understanding using the d effect size. Qualitative data obtained is used to describe students' difficulties in a static fluid material.

Table 1. Indicator and test item numbers distribution

Indicators	Number of test items
Explain the effect of fluid depth on hydrostatic pressure	1, 3, 4, 9
Explain the effect of fluid density on hydrostatic pressure	2, 5, 6
Use the concept of hydrostatic pressure to solve problems	8, 10
Use Pascal's principle concepts to solve problems	11, 12, 13
Explain the influence of density on buoyancy	14, 17
Explain the effect of the volume of the fluid that is exposed to the buoyancy	15, 18
Solving related problems the state of things floating, floating and sinking in a static fluid	19, 24
Use the Archimedes principle to solve problems	20, 22, 25

RESULT AND DISCUSSION

Table 2 summarized the students' conceptual understanding in static fluid concepts that have been carried out in this study, presented as descriptive statistics on the results of understanding tests of the initial (pre-test) and final (post-test) concepts.

Table 2. Descriptive statistics of students' understanding

Descriptive Statistics	Pre-test	Post-test
N	28	28
Mean	32.65	70.41
Maximum	57.14	90.48
Minimum	4.76	47.62
Deviation Standard	14.65	12.59
Variance	214.52	158.49

Table 2 shows an increase in the average value, the maximum value, and the minimum value of understanding of students' concepts from pre-test to post-test. All students experienced an increase in understanding of concepts.

Students' conceptual understanding can also be seen based on the percentage of students' correct answers to the test questions on each concept. Presented in the following table are the percentage of students' conceptual understanding based on its concept.

Table 3. Students' conceptual understanding in every learning indicator

Concept	Percent Correct (%)	
	Pre-test	Post-test
Explain the effect of fluid depth on hydrostatic pressure	25.89	74.11
Explain the effect of fluid density on hydrostatic pressure	33.33	79.76
Use the concept of hydrostatic pressure to solve problems	23.21	78.57
Use Pascal's principle concepts to solve problems	29.76	57.14
Explain the influence of density on buoyancy	67.86	92.86
Explain the effect of the volume of the fluid that is exposed to the buoyancy	17.86	60.71
Solving related problems the state of objects floating, floating and sinking in a static fluid	42.86	55.36
Use the Archimedes principle to solve problems	29.76	65.48

From Table 3, it can be seen that students' conceptual understanding of each learning indicator has increased. Quantitative increase in students' conceptual understanding has also been calculated through Normalize Gain. The Normalized Gain calculation for the value of student understanding in static fluid concepts is presented below.

Table 4. Normalize gain distribution for students' understanding

Category	Frequency	Percentage (%)
High	11	39.29
Medium Up	9	32.14
Medium Below	3	10.71
Low	5	17.86
	Normalized Gain	Category
Mean	0.5347	moderate

In Table 4, the normalized gain average value is 0.5347, which means that the increase in students' conceptual understanding can be categorized as a moderate or upper medium (Sutopo & Waldrip, 2014).

Increasing students' conceptual understanding can also be seen from the reasons for the answers described by students. Students who experienced an increase in understanding of the concepts showed some changes in the reason for their answers, which was initially wrong (at the pre-test) to become correct (at post-test). At pre-test, It appears that students still assume that because distance to the surface is equal to distance to the upper limit of the aquarium, the pressure is the same. While at post-test, students' conceptual understanding has changed to be correct. Students can already understand that all points in the same position in the same fluid will have the same pressure.

The increase in understanding of students' concepts is the impact of the treatment given in this study, namely learning with an integrated e-formative assessment in the collaborative inquiry model. To find out how strong the influence that is given by the integrated e-formative assessment collaborative inquiry model on increasing students' conceptual understanding, then d-effect size is calculated. The results of the calculation of effect size are presented in Table 5.

Table 5. Results of calculation of *d-effect size*

	Pre-test	Post-test
Mean	32.65	70.41
Standard Deviation	14.65	12.59
d-effect size	2,772	
Category	Strong	

Based on the pre-test and post-test answers, it can be seen how far the students' conceptual understanding in static fluid material at the time before and after learning with the integrated e-formative assessment collaborative inquiry learning model has changed. The effect of integrated e-formative assessment collaborative inquiry learning model on students' conceptual understanding is strong.

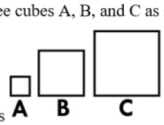
Student Difficulties in Static Fluid Concept

From the percentage of students' conceptual understanding in Table 3, it can be seen which indicators are still low, which means that many students have not mastered the indicated concept yet. Three indicators still have a low percentage of concept understanding. The concept uses Pascal's principle to solve problems, explain the effect of the volume of fluid transferred to floating views, and solve related problems when things float, float, and sink into the static fluid. On these indicators, students experience difficulties in this static fluid material. Some of the difficulties experienced by students after learning are as follow.

Difficulty in Determining Factors that Affect the Buoyant Force

Many students have difficulty understanding the concept of buoyancy on Archimedes' Principle. This can be identified from the results of the work on mastering the concept number 18 (Figure 2).

Three cubes A, B, and C as shown in the picture below have the same



mass

When the three cubes are immersed into the water simultaneously, the beam that gets the biggest buoyant force is....

a. Cubes A **(*Pre*: 28.57%, *Post*: 0 %)**
b. Cubes B **(*Pre*: 10.71%, *Post*: 0 %)**
c. Cubes C **(*Pre*: 25 %, *Post*: 46.43 %)***
d. The three cubes get the same buoyant force **(*Pre*: 21.43, %, *Post*: 53.37%)**

***The Correct Answer
Figure 2. Students' responses on item number 18

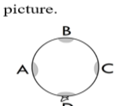
The buoyancy force is the total force given by the fluid to an object inside the fluid. The magnitude of buoyancy force is influenced by the fluid's density, the gravity acceleration, and the object's volume being moved. Even though the mass of two objects is the same, if the volume is different, then the buoyancy force is also different. However, many students still think that the buoyant force acting on an object in a fluid is affected by the object's mass. In question number 18, students tend to be more likely to choose answer D because, in the question, it is stated that the three beams have the same mass. Many students assumed that the buoyancy force effect when the beams are equal.

Such findings confirmed the findings of Apaydin (2014) that students sometimes believe there is a direct relationship between the buoyancy force and object mass. This may occur because of students' intuition or personal experience. Students, for example, very often observe that a stone can float while a cork does not float, even though it is the same size. The association between mass and buoyancy, therefore, is strong. In other words, learning can reinforce the conceptual systems that students have in mind (Hammer & Elby, 2003). Further research into why learners associate mass with buoyancy, however, needs to be done in more depth in the future.

Difficulty in Determining the Buoyancy Force of Non-Liquid

This difficulty can be seen through the results of working on questions number 24 by students. On the question, students are asked to compare the forces acting on a balloon that is floating in the air. The following is presented in the concept of mastering number 24 (Figure 3), which is accompanied by the percentage of students who choose each answer option.

A balloon filled with helium is floating in the air as shown in the following picture.



The following statement which is correct in stating the relation of forces acting on a balloon by air is...

a. $F_A = F_B = F_C = F_D$ **(*Pre*: 35.71 %, *Post*: 50 %)**
b. $F_A = F_C > F_B = F_D$ **(*Pre*: 3.57 %, *Post*: 3.57 %)**
c. $F_A = F_C < F_B = F_D$ **(*Pre*: 25 %, *Post*: 21.43 %)**
d. $F_B < F_A = F_C < F_D$ **(*Pre*: 17.86 %, *Post*: 50 %)***

***The Correct Answer
Figure 3. Students' responses on item number 24

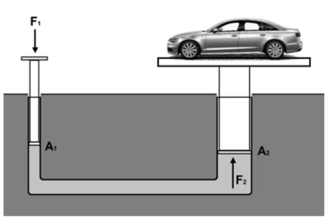
On that question, students who answered correctly were only 50% (D answer) at the post-test. It is seen that students have difficulty if students encounter questions about the Archimedes principle of buoyancy force but not about objects that are in liquid, but rather in other fluids in the form of gas substances. Some students may realize that a balloon floating in the air is surrounded by air, which is also a fluid that gives a force to a balloon and the force given by water to an object in the water.

The association of student learning experiences plays an important role in student understanding, as stated in the previous section. Students often ignore the context when providing an explanation (diSessa, 2018; Gette et al., 2018). In many sources, fluid is more frequently identified as a liquid rather than gas. Furthermore, students experienced more frequent interaction with liquid phenomena, allowing students to provide intuitive explanations. According to Gette et al. (2018), the errors of students in explaining the phenomenon of buoyancy force are not due to a lack of conceptual understanding, but because an intuitive explanation of the phenomenon is possible.

Difficulty in Implementing Pascal's Principle on Hydraulic Machines

This difficulty can be seen through the results of work on the understanding of concept number 13 by students (Figure 4). The question asked students to think about the concept behind a hydraulic machine that applies Pascal's law. The following represents the conceptual understanding of number 13, which is accompanied by the percentage of students who choose each answer option.

Washing a car uses a hydraulic engine to lift a car weighing 16000 N, as shown below.



The following statement that corresponds to the conditions above is...

a. For lift the car, the pressure on A_1 must be equal to the pressure on A_2 **(*Pre*: 7.14 %, *Post*: 7.14 %)***
b. The car will not lift if the fluid pressure on the big piston is the same as the fluid pressure on the small piston **(*Pre*: 14.29 %, *Post*: 21.43 %)**
c. Force F_1 downwards produce force $F_2$with the same magnitude but in upward direction **(*Pre*: 32.14 %, *Post*: 50 %)**
d. If the force F_1 is smaller than the weight of the car, the car doesn't lift. **(*Pre*: 28.57 %, *Post*: 21.43 %)**

*****The Correct Answer

Figure 4. Students' responses on item number 13

On the question both at pre-test and post-test, students who answered the questions correctly (answer A) were only 7.14%. Indeed, students have known that Pascal's Law basic concept in hydraulic machines is that the pressure on small pistons and large pistons are large. This is evidenced in questions number 11, and 12 where many students have been able to use the equation P1 = P2, or F1 / A1 = F2 / A2 to solve a question that asks students to calculate the value. But when students were asked to think about the concept of Pascal's law on the hydraulic machine, many students still experienced difficulties. Many students tend to choose answer C because it is possible for students to think that the magnitude of the force produced on both pistons is equal to the same cross-sectional area. But this is wrong because on both pistons the pressure is the same, but the cross-sectional area is different so the force produced is definitely different.

Such findings confirmed a study conducted by Chen et al. (2013) that the understanding of Pascal's law by students tends to be inconsistent. Students can solve problems in one context, but students fail to provide explanations in other contexts. In addition, this misconception needs to be anticipated because many students believe that the notion of static fluid pressure can be used to explain the notion of dynamic fluid pressure (Suarez et al., 2017).

In general, research have shown that collaborative inquiry learning accompanied by e-formative assessment could improve understanding of static fluid concepts. In other words, this learning impacts students' conceptual understanding and decreasing students' difficulties is the change in students' conceptual understanding of the hydrostatic pressure topic. The initial understanding of most students is to assume that hydrostatic pressure depends on the shape of the container that holds the fluid, which in turn also strengthens the results of the study (Goszewski et al., 2013). However, such understanding is only found in the post-test; most students have been able to master the concept correctly, namely assuming that the hydrostatic pressure is not influenced by the shape of the container that holds the fluid but depends on the depth.

It could be stated that learning with the integrated e-formative assessment collaborative inquiry model could increase student understanding of concepts. In learning with the collaborative inquiry model carried out in this study, students were asked to conduct investigations to find concepts that are being studied in a structured manner. This can help students understand every concept that is being studied well. The results of this study are consistent with the research conducted by (Sun et al., 2017), who found that collaborative inquiry was able to increase understanding of concepts and critical thinking.

The application of e-formative assessment also plays an effective role in helping students learn well. The limited amount of time available for classroom learning can be overcome by a website that can be used to apply formative assessment and authentic assessment. On the website, diagnostic tests and formative questions are provided, which can be used by students to learn and get direct feedback. Effective and efficient feedback on the process of applying formative assessment can increase student motivation in learning (Loughland & Kilpatrick, 2015; Weurlander et al., 2012). Authentic assignments given can make students actively use the concepts they have been able to make an explanation related to the application of these concepts to the real world so that they can understand the meaning behind the knowledge they have acquired. According to Dennis et al. (2013), the application of authentic assessment can help students learn more meaningful.

Students 'difficulties in this study can also be identified based on students' answers to the conceptual understanding test. One of the difficulties of students is in understanding the magnitudes that affect the magnitude of buoyancy. Research conducted by Wagner et al. (2014) found that students found it difficult to understand Archimedes' principles correctly related to buoyancy; the same was found in this study. This difficulty can be seen from the students' answers to the concept of mastering item number 18. Students still understood that the buoyancy force acting on an object depends on the object's magnitudes, such as the mass of the object. This is because the initial conception of students that may not have changed, namely to assume that an object can float or sink, depends only on the object's mass or the object's gravity.

The next difficulty is when students encounter problems related to objects that are in a fluid that is not liquid. In number 24, many students have difficulty identifying the forces acting on a floating balloon. These findings are similar to the results of a study conducted by Loverude et al. (2010), which found that students experience difficulties in the concept of forces acting on objects in a fluid. This is probably due to students not getting enough examples of the application of the Archimedes principle to objects that are in a gas-shaped fluid.

The interesting result found in this study is on the topic of Pascal's law. In the concept understanding questions, there are three Pascal law questions, where two questions are in the form of calculation problems and one in the form of a conceptual problem. The results of the conceptual understanding test show that the two numeracy questions each can be answered by 82.14% of students correctly. Still, for one conceptual question about Pascal's law, it can only be answered correctly by 7.143% of students. However, the portion of conceptual discussion related to Pascal's law during learning is more than the portion of the practice on numeric calculation problems. This shows that there are still many students who have difficulty in understanding the concepts of Pascal’s Law correctly. This difficulty is probably due to not enough learning time for Pascal's law. Indeed, the things to be discussed on this topic are not as much as on the topic of hydrostatic pressure and Archimedes's principle.

CONCLUSION

The research showed that students experienced a positive change in conceptual understanding after learning with the e-formative assessment integrated into the collaborative inquiry model. Although there is a general increase in understanding of static fluid concepts, we also found some students' difficulties. First, students have difficulty in understanding quantities that affect the magnitude of buoyancy. The second is difficulty in understanding the concept of buoyancy when objects were in fluids that were not liquid. The last is difficulty in understanding the concept of force related to the application of Pascal's law to hydraulic machines. These difficulties can be considered to be anticipated by teachers in teaching static fluid.

Providing more conceptual discussions and problem solving on static fluid material is suggested, especially through the application of formative assessment, by giving conceptual questions and then discussing them during learning. For further research using the same learning model, it was recommended to carry out research using experimental classes and control classes and other research subjects.

REFERENCES

Apaydin, Z. (2014). The Knowledge Structures about Buoyancy Concept of Secondary School Students: Phenomenological Primitive Flotation. *TED EĞİTİM VE BİLİM*, *39*(174). https://doi.org/10.15390/EB.2014.3258

Bell, T., Urhahne, D., Schanze, S., & Ploetzner, R. (2010). Collaborative Inquiry Learning: Models, tools, and challenges. *International Journal of Science Education*, *32*(3), 349–377. https://doi.org/10.1080/09500690802582241

Bennett, R. E. (2011). Formative assessment: A critical review. *Assessment in Education: Principles, Policy & Practice*, *18*(1), 5–25. https://doi.org/10.1080/0969594X.2010.513678

Besson, U. (2004). Students' conceptions of fluids. *International Journal of Science Education*, *26*(14), 1683–1714. https://doi.org/10.1080/0950069042000243745

Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. https://doi.org/10.1080/0969595980050102

Chen, Y., Irving, P. W., & Sayre, E. C. (2013). Epistemic game for answer making in learning about hydrostatics. *Physical Review Special Topics - Physics Education Research*, *9*(1), 010108. https://doi.org/10.1103/PhysRevSTPER.9.010108

Dennis, L. R., Rueter, J. A., & Simpson, C. G. (2013). Authentic Assessment: Establishing a Clear Foundation for Instructional Practices. *Preventing School Failure: Alternative Education for Children and Youth*, *57*(4), 189–195. https://doi.org/10.1080/1045988X.2012.681715

diSessa, A. A. (2018). A Friendly Introduction to "Knowledge in Pieces": Modeling Types of Knowledge and Their Roles in Learning. In G. Kaiser, H. Forgasz, M. Graven, A. Kuzniak, E. Simmt, & B. Xu (Eds.), *Invited Lectures from the 13th International Congress on Mathematical Education* (pp. 65–84). Springer International Publishing. https://doi.org/10.1007/978-3-319-72170-5_5

Gette, C. R., Kryjevskaia, M., Stetzer, M. R., & Heron, P. R. L. (2018). Probing student reasoning approaches through the lens of dual-process theories: A case study in buoyancy. *Physical Review Physics Education Research*, *14*(1), 010113. https://doi.org/10.1103/PhysRevPhysEducRes.14.010113

Gijlers, H., & de Jong, T. (2009). Sharing and Confronting Propositions in Collaborative Inquiry Learning. *Cognition and Instruction*, *27*(3), 239–268. https://doi.org/10.1080/07370000903014352

Goszewski, M., Moyer, A., Bazan, Z., & Wagner, D. J. (2013). *Exploring student difficulties with pressure in a fluid*. 154–157. https://doi.org/10.1063/1.4789675

Hammer, D., & Elby, A. (2003). Tapping Epistemological Resources for Learning Physics. *Journal of the Learning Sciences*, *12*(1), 53–90. https://doi.org/10.1207/S15327809JLS1201_3

Handayanto, S. K., Muhardjito, & Wijaya, C. P. (2018). *Scaffolding for solving problem in static fluid: A case study*. 030028. https://doi.org/10.1063/1.5019519

Kusairi, S. (2013). Analisis Asesmen Formatif Fisika SMA Berbantuan Komputer. *Jurnal Penelitian Dan Evaluasi Pendidikan*, *16*, 68–87. https://doi.org/10.21831/pep.v16i0.1106

Kusairi, S., Alfad, H., & Sulaikah, S. (2017). Development of Web-Based Intelligent Tutoring (iTutor) to Help Students Learn Fluid Statics. *Journal of Turkish Science Education.*, *14*(2), 1–11. https://doi.org/10.12973/tused.10194a

Lafuente, M., Remesal, A., & Álvarez Valdivia, I. M. (2014). Assisting learning in e-assessment: A closer look at educational supports. *Assessment &*

Evaluation in Higher Education, *39*(4), 443–460. https://doi.org/10.1080/02602938.2013.848835

Loughland, T., & Kilpatrick, L. (2015). Formative assessment in primary science. *Education 3-13*, *43*(2), 128–141. https://doi.org/10.1080/03004279.2013.767850

Loverude, M. E., Heron, P. R. L., & Kautz, C. H. (2010). Identifying and addressing student difficulties with hydrostatic pressure. *American Journal of Physics*, *78*(1), 75–85. https://doi.org/10.1119/1.3192767

McMillan, J. H., Venable, J. C., & Varier, D. (2013). Studies of the Effect of Formative Assessment on Student Achievement: So Much More is Needed. *Practical Assessment, Research & Evaluation*, *18*(2). Retrieved from http://pareonline.net/getvn.asp?v=18&n=2

Raes, A., Schellens, T., & De Wever, B. (2014). Web-based Collaborative Inquiry to Bridge Gaps in Secondary Science Education. *Journal of the Learning Sciences*, *23*(3), 316–347. https://doi.org/10.1080/10508406.2013.836656

Rahmawati, I. D., Suparmi, & Sunarno, W. (2018). Students concept understanding of fluid static based on the types of teaching. *Journal of Physics: Conference Series*, *983*, 012029. https://doi.org/10.1088/1742-6596/983/1/012029

Rodríguez-Gómez, G., Quesada-Serra, V., & Ibarra-Sáiz, M. S. (2016). Learning-oriented e-assessment: The effects of a training and guidance programme on lecturers' perceptions. *Assessment & Evaluation in Higher Education*, *41*(1), 35–52. https://doi.org/10.1080/02602938.2014.979132

Suarez, A., Kahan, S., Zavala, G., & Marti, A. C. (2017). Students' conceptual difficulties in hydrodynamics. *Physical Review Physics Education Research*, *13*(2), 020132. https://doi.org/10.1103/PhysRevPhysEducRes.13.020132

Sulasih, Suparmi, A., & Sarwanto. (2017). Profile of student critical thinking ability on static fluid concept. *Journal of Physics: Conference Series*, *909*, 012060. https://doi.org/10.1088/1742-6596/909/1/012060

Sun, D., Looi, C.-K., & Xie, W. (2017). Learning with collaborative inquiry: A science learning environment for secondary students. *Technology, Pedagogy and Education*, *26*(3), 241–263. https://doi.org/10.1080/1475939X.2016.1205509

Sutopo, & Waldrip, B. (2014). Impact of A Representational Approach on Students' Reasoning and Conceptual Understanding in Learning Mechanics. *International Journal of Science and Mathematics Education*, *12*(4), 741–765. https://doi.org/10.1007/s10763-013-9431-y

Ucan, S., & Webb, M. (2015). Social Regulation of Learning During Collaborative Inquiry Learning in Science: How does it emerge and what are its functions? *International Journal of Science Education*, *37*(15), 2503–2532. https://doi.org/10.1080/09500693.2015.1083634

Urhahne, D., Schanze, S., Bell, T., Mansfield, A., & Holmes, J. (2010). Role of the Teacher in Computer-supported Collaborative Inquiry Learning. *International Journal of Science Education*, *32*(2), 221–243. https://doi.org/10.1080/09500690802516967

Wagner, D. J., Carbone, E., & Lindow, A. (2014). Exploring Student Difficulties with Buoyancy. *2013 Physics Education Research Conference Proceedings*, 357–360. https://doi.org/10.1119/perc.2013.pr.077

Weurlander, M., Söderberg, M., Scheja, M., Hult, H., & Wernerson, A. (2012). Exploring formative assessment as a tool for learning: Students' experiences of different methods of formative assessment. *Assessment & Evaluation in Higher Education*, *37*(6), 747–760. https://doi.org/10.1080/02602938.2011.572153