GADING (Online) Journal for Social Sciences, Universiti Teknologi MARA Cawangan Pahang
Vol 25(03), October 2022

EVALUATION OF STUDENTS' CONCEPTUAL UNDERSTANDING OF FLUID MECHANICS COURSE THROUGH DIAGNOSTIC ASSESSMENT IN ODL PLATFORM

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Abstract

The fluid mechanics concept is widely applied in current technology and our daily lives, requiring students to understand the significance of this concept. The issues arising for the Civil Engineering Diploma students who have difficulties understanding physics concepts in Physics course (PHY145) at semester 1 and lead to more complex concepts in fluid mechanics course (ECW231) at semester 3 through the Open and Distance Learning (ODL) platform. Physics course act as pre-requisite to enroll in fluid mechanics course. Present research investigates students' conceptual understanding of physics using a diagnostic assessment. The diagnostic assessment is an entering test for fluid mechanic's course. The result obtained from the distributed diagnostic assessment question is analyzed to achieve this objective. A survey also was conducted to determine the necessity for diagnostic assessment in Fluid Mechanics course. The major findings of the study are 100% lecturers agreed that diagnostic tests could help them detecting student weaknesses at early stage. Hence, teaching-learning strategies and approaches must be adjusted according to students' learning needs.

Keywords: diagnostic assessment, fluid mechanics, understanding concepts, open and distance learning (ODL)

Introduction

Higher education is gradually flexible delivery modes, providing multiple pathways and opportunities for further education (Gillett-Swan, 2017). ODL is related to its flexibility, accessibility, affordability, and life-based education opportunities that suit the conceptual and calculation courses (Azmi & See May, 2021). The technology used for online teaching and learning comes with the benefits of improved access, the interaction between lecturer and students, access to a wide variety of available resources, and content sharing by lecturers through the learning platforms (Mathew & Iloanya, 2016). However, the students' conceptual understanding is influenced by pedagogical and technical support arrangements used to interact between lecturers and students for effective collaboration (Curtis & Lawson, 2001). This condition discourages students from understanding the underlying scientific concept. Therefore, students prefer to just memories the theory from notes (Thompson & Logue, 2006). What do we essentially mean when we say students have conceptual understanding? According to Mathew & Iloanya, (2016), when students have an understanding of a concept, they can think with it, practice it in areas other than that in which they learned it, state it in their own words, discover an analogy for it, or design a mental or physical model of it. In other words, the students have made the concept their own. This is what we call conceptual understanding.

Teaching-learning of science empowers students to make sense of natural and physical world (Irwansyah, Sukarmin, & Harjana, 2018). It is about engaging them in practices of science and facilitating them to use their understanding in novel situations. In a formal set -up, one of the indications of conceptual understanding can be through students' achievement in the assessment. If students are not able to apply their understanding in novel situations, it can be presumed to have difficulties in conceptual understanding as one of the impeding factors of low achievement in the assessment.

Therefore, various researcher developed instrument to determine students conceptual understanding of science concept including physics concept. Halim (2017) and Martin, Mitchell, & Newell (2003) developed diagnostic test instrument and Fluid Mechanics Concept Inventory (FMCI) to evaluate students' understanding of the vital concept and identify the common misconceptions to understand student perceptions of fluid mechanics. The diagnostic assessments support the personalization of learning, adjusting teaching to students' personal needs (Csapó & Molnár, 2019). In addition, Mitra (20003) in her research revealed that early discovery of student's level of conceptual understanding can help in improving their learning experiences. At the same time, failure to engage with students in the teaching and learning process risks increasing disengagement amongst learners with their educational experiences.

At UiTM Pahang Branch, the fluid mechanic course was offered by the school of civil engineering and is highly relevant in mechanical, chemical, petrochemical, civil, metallurgical, biological, and ecological engineering. Fluid mechanics is a subject that is particularly open to interchange with other sciences and disciplines of engineering (Makinde, Khan, & Chinyoka, 2013). This interchange makes fluid mechanics concept more complex and difficult. Understanding the concept is the basic and essential for the learning process because students can solve questions and learn in the real world (Akbas & Gencturk, 2011). The concepts in fluid mechanics are arranged systematically, logically, and hierarchically from the simplest to the most complex. However, some of students consider the concepts in Fluid mechanics course are complex, complicated, and time-consuming to understand (Cari, Pratiwi, Affandy, & Nugraha, 2020).

According to Azmi and See May, 2021, knowing students' understanding of physics concepts and involving them in plannings about education can teach lecturers about changing teaching and learning processes, and determine whether students are committed to learning. Study of Halim (2017) exposes that student can contribute to almost all aspects of learning. Besides, it is imperative for the lecturers to recognize and address students' difficulties and concerned ideas to familiarize themselves with student's perspectives of understanding physics concepts. Looking from this perspective, the present work has been conceived on two premises– lecturers' views on necessity for diagnostic assessment in Fluid Mechanics course and students' views on difficulties in their conceptual understanding of Physics concept. We have taken students 'views on the teaching-learning process of fluid mechanics using a diagnostic assessment and distributed to the students in an early semester. Though there might be various dimensions of conceptual understanding, we have focused on students' understanding on thier conceptual understanding of Physics. Fulfilling those targets can help lecturers develop a suitable corrective plan to assist the lecturer in correcting their errors and improving the learning approach applied in the lecture session. This study contributes to the body of knowledge in analyzing the reason misconceptions and ways to improve the students' understanding of fluid mechanics.

Research Methodology

The study on the students' conceptual understanding levels on Fluid Mechanics during ODL was carried out using diagnostic assessment. This technique is an appropriate research method that is widely used for quantitative research. A completely unstructured question type was chosen for this study (Roopa & Menta Satya, 2012). The target population of this study is the study that takes the Fluid Mechanics course for the concurrent semester. The survey also has been conducted and the sample consisted of 14 fluid mechanics lecturers. The data analysis technique used quantitative analysis from the questionnaire results. The questionnaire contains knowledge of diagnostic assessment and the necessity for diagnostic assessment based on the opinion of the lecturer.

Results and Discussions

This research data was obtained from a survey to determine the necessity for diagnostic assessment in Fluid Mechanics course. **Table 1** shows lecturers' opinions on the need for diagnostic assessment. All 14 respondents/lecturers had used diagnostic assessment for their students. This was the warm-up item of the questionnaire in the beginning. 71.4 percent of lecturers say that the students have difficulties in understanding some or other concepts of fluid mechanics during ODL. The results also show that 92.9 percent lecturers require diagnostic assessment to detect student weaknesses in learning fluid mechanics. Their students' weaknesses, making it difficult to get satisfactory fluid mechanics scores. Therefore, the diagnostic assessment is vital. The lecturer also hopes it would be better if the diagnostic assessment could be made for each chapter on the fluid mechanics' course. 100% of the lecturer who became respondents agreed that the diagnostic assessment could help lecturer recognizing student weaknesses in fluid mechanics' course. Then, lecturers are able to plan teaching and learning activities aiming at strengthening the weaknesses of students such as mentoring program. Overall, the survey revealed that the lecturers apply diagnostic assessment in their class is relatively high. This is because the information about the difficulties of students in understanding fluid mechanics concept are very important component to be able to achieve effective fluid mechanics teaching. Dewi, Samsudin, & Nugraha, (2019) stated that the weakness of students in understanding the lesson can hinder the process of absorbing new knowledge after learning. Therefore, the weaknesses that students have must be detected immediately.

Table 1 The opinion of the lecturer's need for diagnostic tests

No	Questions	Results (%)	
		Yes	No
1	Have you ever used diagnostic assessment for your class?	100.0	0.0
2	In your opinion, are there students who have difficulty understanding fluid mechanics in ODL platform?	71.4	28.6
3	Do you know the weaknesses of students that make it difficult for students to get good grades?	78.6	21.4
4	In your opinion, do lecturers need the diagnostic test to detect student weaknesses in learning fluid mechanics?	92.9	7.1
5	In your opinion, does a diagnostic test need to be made for each chapter on fluid mechanics' course?	78.6	21.4
6	Do you agree that diagnostic tests could help lecturer performance in detecting student weaknesses?	100.0	0.0
7	Do you agree that diagnostic test (pre-test) able to improve students'	85.7	14.3

	grades (post-test)?		
8	In your opinion, does the diagnostic test should be used for next semester?	92.9	7.1
9	Would you think that diagnostic test has influenced your teaching activities?	78.6	21.4
10	Would you think that diagnostic test helps you to plan remediation activities	85.7	14.3

In addition, this study aims to measure the students' understanding of fluid dynamics by answering the questions for each topic in fluid mechanics using a diagnostic assessment. The assessment was divided into five main topics: unit and dimension, Newton's law of motion, pressure and buoyancy, rotational motion, and hydrodynamics. **Figure 1** shows the percentage of difficulties for every Fluid Mechanics topic based on the answers provided by the students in the diagnostic assessment. The most challenging topic is hydrodynamics, 38% followed by rotational motion, 22%, and Newton's law of motion, 20%. The concepts of pressure and buoyancy shows the difficulty percentage is equal to 15%, while the concepts of unit and dimension shows a low percentage value on the level of difficulties compared to other topics, which is only 5%. This probability situation due to pressure and buoyancy concepts are closely related to our daily life. On the other hands students may have forgotten the concepts of their previous classes. They are not able to link the concepts being transacted in the class with their previous experiences, which is one of paramount importance for construction of knowledge.

Each student is unique and learns with his own pace. Paying attention to the learning needs and learning styles of students is an essential part of teaching-learning process (Mokhtar et.al., 2021). Lecturers are hard pressed for time to cover the syllabus. Thus, by knowing the most difficult topics as shown in **Figure 1**, it helps them to plan the class schedule and academic calendar. It implies that how to transact the concepts in the allocated time framework with students' friendly pace should also be part of the capacity building programme of the lecturers. It is importance to link the concepts being transacted with students' existing ideas and the relevant concepts they have. New concepts need to be anchored on those concepts. One of the ways to find their existing ideas can be relating the concepts through their daily life experiences. This can make students find its relevance to their daily life and hence facilitate understanding. It is important to link within the classroom and beyond the classroom experiences to help students in making meaning of the concept.

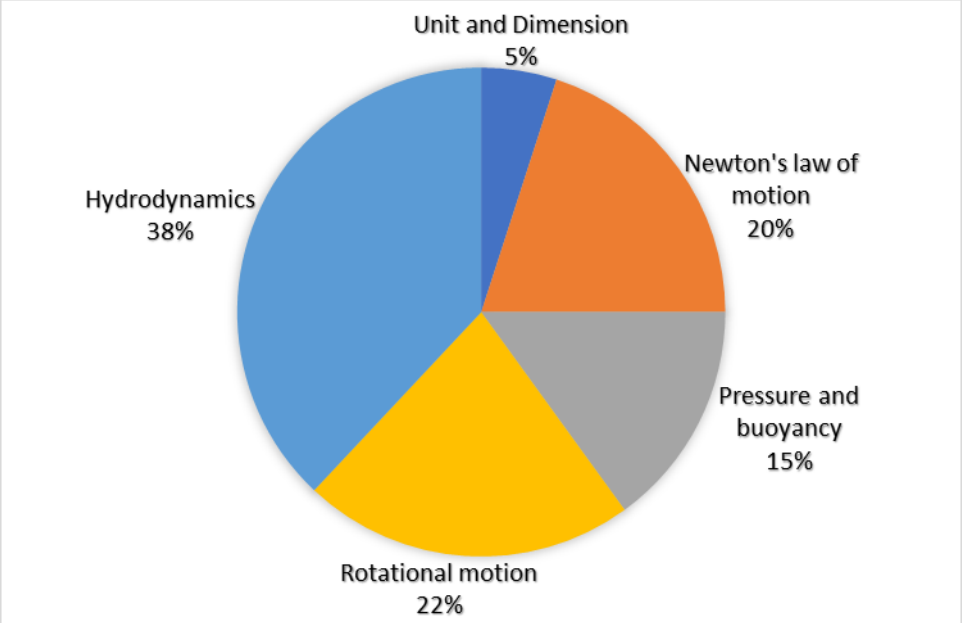

Figure 1 The percentage of difficulties for every topic in fluid mechanics.

The data of this research were obtained from the results of EC110 Students from semester 20192 to 20212. The results of students' failure rate in diagnostic assessment (PRE-Test) and final examination (POST-Test) were compared as shown in **Figure 2**. The results indicate that the failure percentage decreased in post-test for every semester. The Pre-test (diagnostic assessment) effectively indicated students' prior knowledge, hence helping the lecturer give more attention to selected students who are weak in physics knowledge. In addition, the lecturer also can provide exciting activities to encourage more effective learning. Dewi, Samsudin, & Nugraha, (2019) also agreed that the diagnostic assessment provides initial knowledge of the students from previous learning. This can facilitate lecturers to better integrate activities in class with concepts being transacted as well as recognize and address the concepts that students find difficult.

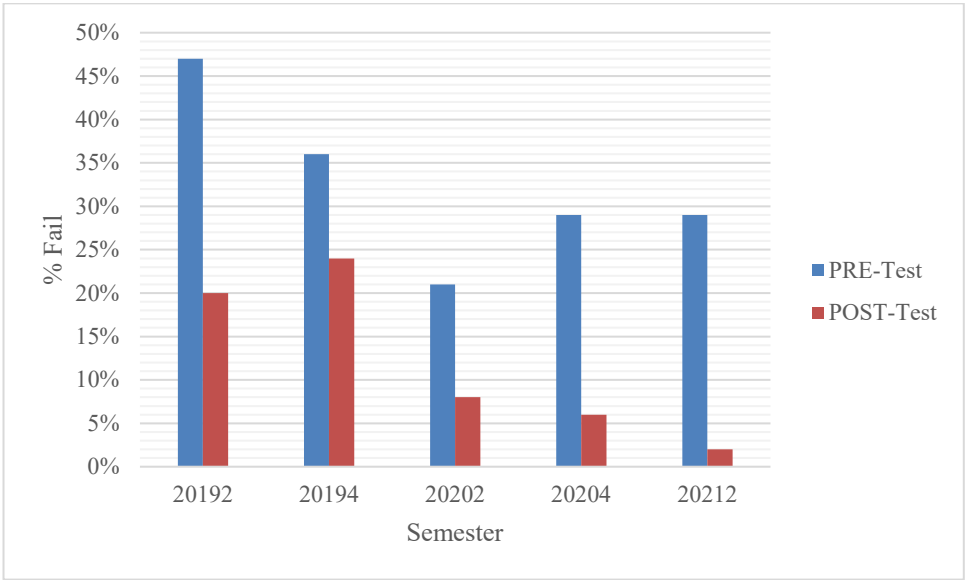

Figure 2 Students' failure percentage in Pre-test and Post-test.

Conclusion

In conclusion, the study positively gives good feedback regarding students' understanding which reflecting on the students' thinking, strength, and weaknesses. The diagnostic test allows lecturers to identify students who are weak in physics knowledge and prepare a suitable corrective plan to improve the learning approach for the next lecture session. For the Fluid Mechanics course, the percentage of difficulties based on the topics was determine as follows, Hydrodynamics, rotational motion, newton's law of motion, pressure and buoyancy, followed by unit and dimensions. The misconceptions appear more in the complex topic and influence the students' results. This study further suggests that the lecturers collect suggestions from students related to the suitable learning approach implemented in a lecture class. Moreover, the future research also can use diagnostic instruments not only at the beginning of each semester but also on completion of a specified topic. This is to have better view on the students' understanding on the fluid mechanics concepts.

Acknowledgement

We would like to show our gratitude to the students and lecturers from the class of Fluid Mechanics, School of Civil Engineering, College of Engineering, UiTM Pahang, for answering the questionnaire and sharing their wisdom with in completing this study.

Conflict of interests

The authors have no conflict of interest to declare. All co-authors have seen and agree with the manuscript's contents, and there is no financial interest to report. We certify that the submission is original work and is not under review at any other publication.

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