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# Engaging Students in Online Data Analytics Learning: Meaningful Learning in Higher Education

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## Abstract

The implementation of full online teaching and learning activities in Higher Educational institutions invites tangible challenges to sustain students' interest and engagement in the course, throughout the semester. Meaningful learning encourages students to develop concepts constructively in active learning that promote the integration of knowledge in daily life and potential career applications. Meaningful learning also applies richer application capabilities in synchronous or asynchronous learning systems. Visualization is a technic to support concept description and imagination and provide an additional effective layer for learning towards increased motivation. In this paper, a discussion of the active involvement of students using visualization in online data analytics courses at the tertiary level is presented. Based on functional context principles of visualized course content, recommendations to practitioners are discussed.

**Keywords** online learning; meaningful learning; engagement

## INTRODUCTION

Online learning takes place in digital education, during the period of much challenging time, such as pandemic outbreaks. Practically, online learning replaces the traditional face-to-face learning without much preparation by the educators in the swift. Online learning requires educators to plan their lessons well as to how to engage students in the learning materials and encourage them to understand and apply the learned concepts.

In online learning, active learning tasks use constructive and collaborative activities. Active learning plays an important role in engaging students, developing their interests, and encouraging them to participate in the learning process. Nonetheless, providing facilities and occasions to encourage communication and discussion does not guarantee collaboration and engagement by itself [1]. One way to create the pre-conditions for students' engagement involves visualization for them to explore the concepts and relate to their own experiences and current knowledge [2].

In the online learning process, instructors play their part as facilitators to actively involved in the discussion process [3]. Instructors facilitate the learning by clarifying any misunderstanding of concept meaning and interpretation. Instructors also guide clear presentation and communication to focus on the topic and generate alive interactions.

Instructors encourage students to relate new concepts being learned to existing cognitive structures through concept modification and construction of new links[4]. This meaningful learning strategy produces a longer memory than memorization, as well as allows real learning to take place to facilitate the transfer and application of learned concepts to the real world [5], [6]]. Meaningful learning also helps students improve holistic skills covering cognitive, psychomotor, and affective aspects [7].

Instructors of data analytics courses find that meaningful learning helps students build a deeper statistical understanding and to transfer what they learn in the future class or the real life application [8]. Meaningful learning content is enriched with embedded elements that comprise of active learning, cooperative learning, authentic learning, objective learning, and constructive learning [9]. In this article, we discuss active involvement of students using visualization in online data analytics courses at the tertiary level.

## MEANINGFUL LEARNING IN HIGHER EDUCATION

Meaningful learning associates new information with existing concepts in the cognitive structure [10]. The strong connection between new concepts and the existing concepts encourage for longer retention of information than memorization. These connections bring about changes in an individual's cognitive structure by modifying original concepts and new links are created. The three factors that influence meaningful learning are the existing cognitive structure, the stability of knowledge, and the clarity of the knowledge being learned.

In meaningful learning, prior knowledge is considered to be most important in the teaching and learning process [11]. The combination of new information with existing ones enhance the cognitive structure, significance, and attribution of meaning. Students do not memorize but learn with logical and meaningful comprehension through planned activities. Various play activities such as involving comics may manipulate academic development to recognise ideas, cultivate skills and play social roles [6].

Meaningful learning involves concept modification and new links construction [4]. This approach not only produces memory, but also involves real learning to accommodate the transfer and application of learned concepts to the real world. Learning means emphasizing the active involvement of students in rewarding and challenging experiences involving real-world situations as well as the application of knowledge to new situations [12].

Meaningful learning entails an active process to promote a deeper and wider comprehension of concepts. The results of interactions between new and previous knowledge result in long-term changes in knowledge and skills [13]. Meaningful learning occurs when complex ideas and information are combined with students' own experiences and knowledge to form their understandings.

Meaningful learning can only be achieved when the learning material is appropriate to students' cognitive structure [10]. The cognitive structure in question is the facts, concepts and generalizations learned and remembered by students [14]. Therefore, the suitability of learning materials should be commensurate with the ability and relevance of students' cognitive structure. Meaningful learning occurs when students understand the relevance learned to other knowledge. Thus, the intellectual and emotional factors of students are involved and active in learning activities.

For that reason, three benefits of meaningful learning related to information learned meaningfully is long retained, systematic knowledge structure for linking the new with prior knowledge, potential use of old information and less practice. Besides, learning means not only strengthening existing capabilities but also encouraging the development of skilled, knowledgeable human capital and attitudes to achieve greater levels of responsibility in the future. Meaningful learning trains students to carefully choose to connect new knowledge with prior knowledge and to assimilate new knowledge into their real-world workflows; and eventually to propose efficient, flexible, innovative, and creative solutions with the help of technology [4].

Meaningful learning is successfully implemented when the learning environment has elements of active, constructive, purposeful, collaborative, and confronted with authentic topics [15]. To ensure that meaningful learning is implemented, the use of technology should be mobilized to facilitate learning events that blend meaningful learning features that are interrelated, interactive, and dependent [16]. This is because technology can bring about a learning environment that stimulates, motivates, challenges, and actively engages students and interacts with learning materials.

Meaningful learning has received enough attention by educators at various levels of education in Malaysia, to provide an engaging and stimulating learning environment, so that the gained knowledge is ready to be used in various aspects of life [17]. Meaningful learning is considered to coincide with 21st-century learning to prepare students who are critical thinking and ability to solve problems in daily life [18].

The emphasis on meaningful learning on the explicit relevance of learning content to daily life prompted researchers to apply this approach in teaching and learning [19]–[21]. Instructors play an important role in realizing meaningful learning by choosing the structure and context of learning carefully [22]. Instructors can stimulate and guide activities that trigger thinking among students about what they are doing [20]. In addition, the integration of hybrid learning and web technology is manipulated to promote a meaningful learning environment [23].

Having discussed the learning approach in detail, this study further discusses meaningful learning in tertiary-level data analytics courses in the next sub-section. These include emphasizing the importance of meaningful learning to address challenges and problems in data analytics learning, elaborating constructivist learning theories in meaningful learning, and refining how meaningful learning can enhance conceptual understanding in data analytics courses.

## MEANINGFUL ONLINE DATA ANALYTICS LEARNING

The main reason for applying and designing a meaningful learning experience in online data analytics learning is of its effectiveness to help students build a deeper understanding of data analytics [8]. Further, these students are expected to be able to transfer what they learn in the next class or the real world. Moreover, traditional teaching approaches face serious problems involving students rarely having the opportunity to develop a deep understanding of what they are learning, and quickly forget it once they complete the course [24].

In a meaningful learning approach, course instructors act as coaches, study partners, or facilitators, rather than as intermediaries of knowledge in an instructor-centered classroom [25]. Among the main roles of course instructors is to provide motivational challenges, to formulate and provide the criteria, planning, timeline, resources, and support needed to ensure student success. Instructors are better suited to function as facilitators who guide students to deal with difficulties and problems that arise, than as dictatorial teachers.

Data analysis should be the focus for meaningful data analytics learning where interesting data sets motivate students to engage in activities, especially conducting appropriate analyses and discussing how data collection methods and types of analysis used can affect research quality [26]. Learning should also train students with statistical reasoning skills and research-based activities as well as encourage collaboration, interaction, and discussion [27]. Such activities not only enhance short-term mastery, but also bring a positive influence on long-term retention, or depth of understanding of course material; fostering critical thinking and creative problem solving; the formation of a positive attitude towards the subject being taught, and increasing the level of confidence.

With the help of technology tools, students can gain support to develop statistical understanding and thinking using communication technology devices, graphing calculators, games and gamification, the Internet, statistical software, and so on. Such tools are not only useful for producing data analytics including graph presentation and data visualization but also help students visualize concepts and develop an understanding of abstract ideas through simulation [28], [29].

The availability of various learning materials in online learning allows students to access and provide learning materials in an environment that is their priority [23]. Learning means more widely accepted in online learning where communication technology platforms make learning more relaxed and more accessible to students. Meaningful learning should lead to increased interest in learning because interested students can learn more effectively [30].

Reliable and consistent learning materials encourage students to produce tangible and practical outputs and eventually be able to share with others. By incorporating authentic learning in the lecture room, course instructors can make it easier for students to engage all the senses to produce meaningful and rewarding learning outputs. Authentic learning can involve real-life assignments or simulation tasks that allow students to connect directly with the real world.

In contrast to conventional data analytics classes, meaningful learning requires classroom discourse through carefully selected and designed activities and technologies [31]. Effective classroom discourse features involve statistical arguments and explanations of how organized data elicit an understanding of the phenomenon being investigated; while students engage in an ongoing exchange of opinions that focus on important data analytical ideas [32].

## ENGAGING STUDENTS IN MEANINGFUL ONLINE LEARNING MODEL

Student engagement gets the most attention from online learning educators and the research community nowadays. In online higher education learning, the integration of technology aims to supply ort learning process by increasing student engagement [3]. More discussion on recent development and trends in learning techniques and tools report enhancement of instructor and student interactions. These interactions contribute to student engagement positively.

In higher education online learning environments, learning processes are integrated into student-centered learning atmosphere. In this setting, instructors create a learning environment that promotes more active students' engagement. The setting encourages students to develop critical thinking skills. Active learning can be defined as a cognitive activity that involves students in doing something and thinking about the things they are doing. Therefore, in online data analytics learning, students are exposed to various tasks to be able to explain, question, consolidate, and adapt new knowledge [33]. This is because learning is based on the process of appreciating new concepts. Students can learn and adapt to the environment through exploration and manipulation of the environment using available tools and information.

Active learning processes may be diverse from various forms of tasks and learning activities. Active learning entails participation from students to boost them to think, research, reflect, and explore more about the learned topics. In a way, active learning acts as an external motivator to support students to engage in deeper learning.

Active learning may work based on constructivism theory. Students build knowledge on conceptual understanding through interaction with previous knowledge while building confidence and intuition [34]. Students are trained to leverage their knowledge to be used in new and different situations. Students' ability to actively participate in the process of making meaning so that the knowledge they build is not inert or wasted [35].

Learning should be active and not passive or purely memorized. Active learning is achieved if students have autonomy in their own learning, by making decisions about their learning outcomes and appreciating the assignments given [36]. Active learning occurs when the ideas and concepts learned are implemented and tested on their own with minimal help from the instructor. In active data analytics learning, students solve problems on their own using the concepts learned based on the examples given. Students deepen the use of statistical concepts and appreciate the learning problems that arise, and find solutions to overcome them.

Active learning is one of the student-centered strategies that can involve various forms of activities in and out of the classroom [9]. Active learning can attract students to be better prepared to follow the learning process with interest. This ability to learn on one's own is the ultimate goal of active learning. In addition, multilateral communication also results from an active learning process.

In online learning, students constructively develop knowledge as opposed to spoon-feeding. The open boundary invites students to play an active role to control their learning, students are stimulated to exhibit their critical thinking capacity, relate their knowledge to the prevailing events, to reflect and become increasingly active in interaction and discussions. Instructors facilitate the learning process to foster students' engagement in many ways. For example, instructors can remind students engagement in the course content after the topic is discussed in the class, or discuss the topic in advance to stimulate students' interest and allow them to construct their knowledge.

Contextual learning takes place in online learning to stimulate students' ability to relate the learned concept for real-life application. Instructors who are keen to provoke internal motivating factors using different tasks prepare students with deep learning. The surrounding allows students to exhibit elements of critical thinking skills. In terms of practicality, students get exposure to explain the subject matter in an everyday circumstance. Flexible and non-compulsory assignments enrich students with options that require them to reflect their current performance and learning target to achieve. Therefore, these learning activities

aim to stimulate students' cognitive and affective progress. In student-centered learning environment, students appreciate self-regulated learning and establish a more dynamic engagement in their learning progression.

In online learning, constructive learning encourages students to build their understanding and knowledge about nature through their experience [37]. Thus, students are responsible for seeking their knowledge and learning new things that can be utilized in developing their potential and skills [35]. Knowledge can only be built on an individual's understanding and cannot be transferred from the thoughts of one individual to the thoughts of another individual.

Constructive learning helps to effectively enhance the roles of students and instructors. In student-centered learning, students interact with learning materials and environments to gain understanding [9]. Thus the concepts and solutions to learning problems are constructed by the students themselves by using their experiences selectively. Instructors act as facilitators in helping students actively build knowledge and solve problems. In this process, students will adapt the received knowledge to existing knowledge to build new knowledge. In addition to the facilitator, the instructor also acts as a designer of teaching materials in addition to identifying the existing knowledge of students and planning teaching methods by the nature of the knowledge base.

Constructive learning also promotes students to construct their knowledge through collaborative activities. Fruitful outcomes from the collaboration stimulate students' peculiar interest and original apprehension. By exchanging their thoughts and perspective on the subject matter, collaboration members explore conceptual understanding in an interesting communication. Collaborative activities allow students to ask, negotiate and communicate with peers, stimulating their social presence significantly.

Collaborative learning refers to an environment in which a group of students is involved in a learning task and requires each individual to contribute to the group and be responsible to each other [38]. Therefore, collaboration to find understanding, meaning or solution is important for creating an effective learning environment.

Peer network built-in collaborative groups allow students to support each other socially and academically including assisting students in dealing with common difficulties such as stress and isolation [39]. This network serves as a solid foundation in effective peer learning because there is a strong motivation and cumulative energy that has the potential to solve learning problems effectively where students feel comfortable and willing to share knowledge and experiences, exchange ideas, and help each other [40].

## CONCLUSIONS

This paper discusses in details approaches to engage students in meaningful online learning. The case applies implementation strategies in the teaching and learning of data analytics at the tertiary level. A meaningful learning approach suits data analytics courses because its effectiveness helps students build a deeper understanding of statistics and encourages the application of concepts in everyday life. Learning may be associating new concepts that are being learned with existing cognitive structures stimulate students to revisit their learning materials and consider modification of concepts. The construction of learning links to produce memories supports a stronger structure that takes a longer period than memorization, as well as enables actual learning to take place.

The paper proposes a model of engaging students in meaningful online learning. Although the context applies data analytics learning, the general principles of meaningful learning could be generalized to wider circumstances in higher education learning. The model requires further evaluation in its validation and further discussion of its application. Therefore, the study recommends future work to execute the model using empirical data on higher education learning. More research is welcomed to identify the successful practices of meaningful learning to observe students' behaviour engagement and to inform instructors on the presence needs in order to develop student–centred activities in online learning.

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