



The Design and Development of Online Authentic Learning Environment for Knowledge Construction in Learning Inferential Statistics

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Abstract

One of the major problems in learning statistics is due to the learning decontextualized from the real world experience. The students are unable to apply statistical knowledge learnt in real world upon completion of the course. The authentic learning is viewed as a favourable approach in statistics delivery to overcome the problem. However, implementing authentic learning in online platform can be extremely resource intensive and costly to develop. Therefore this paper looked into an innovative and cost effective approach to incorporate the nine critical characteristics of Authentic Learning Model by [Herrington and Oliver \(2000\)](#), underpinned by [Vygotsky \(1978\)](#) Social Development Theory and [Lave and Wenger \(1991\)](#) Situated Learning Theory to develop an online authentic learning environment (OnALE) that foster students' knowledge construction in learning inferential statistics among non-statistics major undergraduates. This environment is established in a social learning network, *Edmodo* by incorporating Web 2.0 technologies. Perception survey done indicates that OnALE assisted students learning.

Keywords: Online authentic learning; Online learning environment; Knowledge construction; Inferential statistics; Social learning.



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1. Introduction

In the 21st century learning, the outcomes focused on equipping the students with life-skills. Online course research has by far focused on the creation, technique, and implementation of course material. However, particularly in online learning, students need to feel motivated to participate in discussion to ensure their successful completion in the online course, with mastery of the knowledge for practical use.

One of the courses that has gained attention in using online platform for delivery is the statistics course for non-statistics major undergraduate because it is usually the compulsory subject that serve huge number of students and online learning is viewed as cost saving mean of course delivery ([Bowen et al., 2014](#); [Navimipour and Soltani, Z. 2016](#)). Online learning mode is also preferred for this subject because of technical reasons, such as its ability in assisting visualisation and animation of the concepts in statistics.

The current statistics course delivery has failed to provide contextual learning for students in learning inferential statistics meaningfully ([Cobb, 2015](#)). Upon completion of the statistics course, students are unable to apply the knowledge learnt in their research project or in real-life dealings, even for students scoring high grade in the course ([Fawcett, 2017](#)). As we advanced into the age of information, we need to train people to be statistically literate at workplace and also in their daily life ([Berenson et al., 2008](#); [Gould, 2010](#); [Tishkovskaya and Lancaster, 2012](#)). The students need to be taught to think about social situations in which data are used and to give students an understanding of and hands on experience with the role of statistics in scientific discovery ([Everson, Gundlach and Miller, 2013](#)).

It has been recognized that the students of the 21st century think and learn differently than those from previous generations ([Cash, 2017](#); [Ertmer and Newby, 2013](#)). This trend suggests the need to revisit and potentially update conventional teaching practices. Implementing real-life authentic learning in online setting is considered a favourable instructional approach in assisting students learning inferential statistics. Hence, in this article, we describe the development of an online authentic learning environment (OnALE) for learning inferential statistics, aimed at supporting knowledge construction among learners.

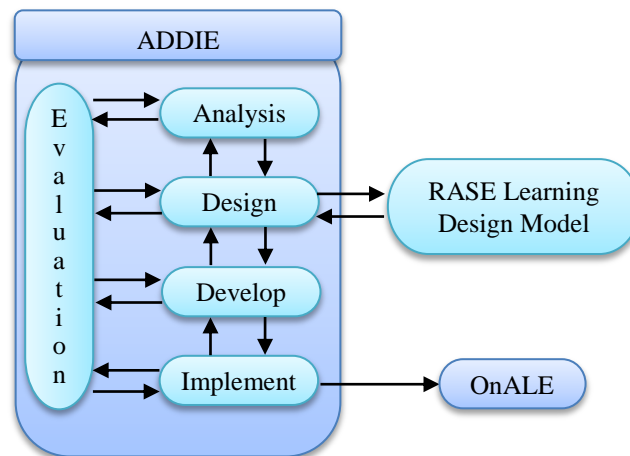
2. Material and Method

In assisting non-statistics major students to learn inferential statistics contextually on online platform, OnALE is designed and developed based on the framework proposed by [Lau and Tasir \(2018\)](#). This framework incorporates Authentic Learning Model by [Herrington and Oliver \(2000\)](#), underpinned by [Vygotsky \(1978\)](#) Social Development Theory and [Lave and Wenger \(1991\)](#) Situated Learning Theory. OnALE is set up in *Edmodo*, a social learning network.

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The ADDIE Instructional Design Model (ISD) model is used in the design and the development of the OnALE. Figure 1 shows the framework for the design and development process. ADDIE model is chosen as the generic steps provides flexibility for this model to become a plug and play model where instructional designers can add other components to it on an as needed basis Clarke (2009). The present study adapted RASE (Resources-Activity-Support-Evaluation) Learning Model (Churchill, King and Fox, 2013) for the main features of the OnALE. RASE Learning Model is chosen because this model caters for the need of the 21st century learners.

Figure-1. Framework for the Design and Development Process



2.1. Component of OnALE

To establish the nine critical characteristics of an authentic learning as in Authentic Learning Model by Herrington and Oliver (2000), the main components of the OnALE were first established, based on RASE Learning Model but modified to fit into the context of authentic learning.

The two main underlying theory behind authentic learning are Situated Learning Theory and Social Development Theory. The situatedness of the context in OnALE is embedded in the authentic task for the students to solve. This task is similar in its functionality as to an Activity in RASE Learning Model. To enable social interaction for learning in OnALE as promoted in the Social Development Theory, forum within groups for discussion is utilised. Other than these two main components, the rest of the component in RASE, namely Resources, Support and Evaluation are also considered as component of OnALE. Hence, the main components of OnALE consisted of the Task, Forum & Groups, Resources, Assessment and Support. Each of these components is described in the following subsections, along with functions in *Edmodo* that the component rely on.

2.1.1. Task

Task is the major component of OnALE, which consists of activities, investigations and problems that enable students to interact with the learning environment and to practice newly acquired skills. This task plays the role to establish the characteristics of authentic learning. The task resembled life-like task i.e authentic task, which is ill-defined and complex. It is presented to the students as project work to be done collaboratively in small group. There are several possible acceptable solutions to the project. The task requires a project report at the end of it. The authentic task is revealed to the student in stages using variety of functions available in *Edmodo*.

2.1.2. Forum & Groups

The *forum* in OnALE is the platform where the users interact with each other for social learning. Every users can initiate a discussion by posting on the wall of the chosen classes or groups in *Edmodo*. The discussion thread within a post on the wall are arrange in chronological order. All the posts also appears in chronological order. This allows the learners to crisscross the wall at later time when needed.

The *groups* for forum discussion in OnALE enable discussion to be held within learners of same interest on their posting wall (Figure 2). This grouping can be done at class level or small groups within a class level using the *Classes* and *Groups* function (Figure 3) in *Edmodo*. The formation of classes and groups are done by instructors and students will join a particular class or group by invitation from instructor.

Figure-2. The Posting Wall (Forum) in Edmodo

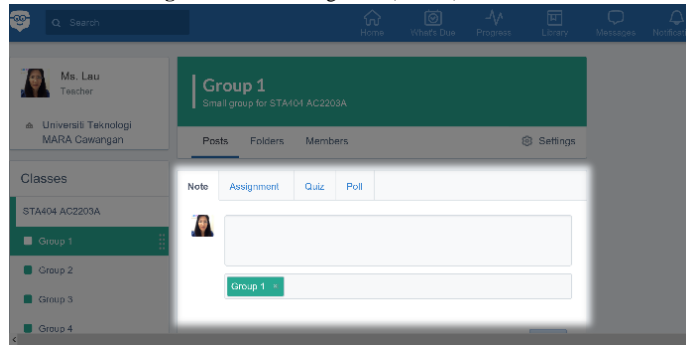
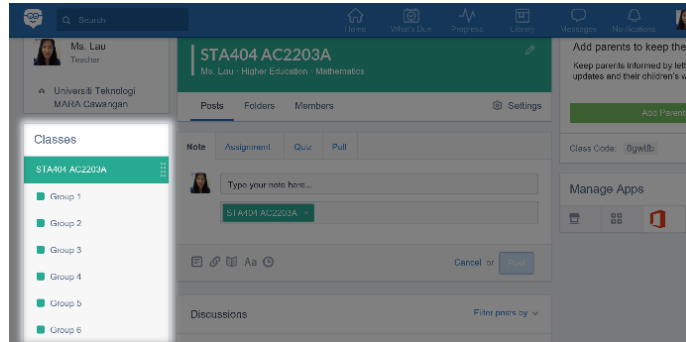


Figure-3. The Classes and Groups in Edmodo for Instructor



2.1.3. Resources

In OnALE, the resources component consists of the digital learning materials such as YouTube videos, web content, audio files and also softwares that allow the students to experience authentic learning. The sharing of the dynamic learning materials can be done via web links directing to the website where the materials are located. Sharing of static learning materials such as notes, slides and e-books are stored in the *Library* function in *Edmodo* for instructors (Figure 4) or the *Backpack* function in *Edmodo* for students (Figure 5). Sharing of materials from the *Library* or *Backpack* is possible when the instructor or the students shared their material to a particular group.

Figure-4. The Library in Edmodo for Instructor

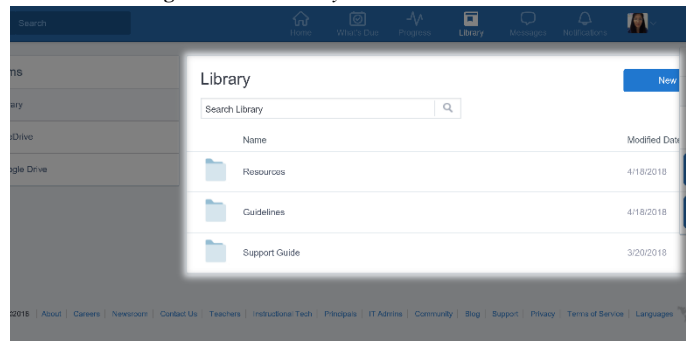
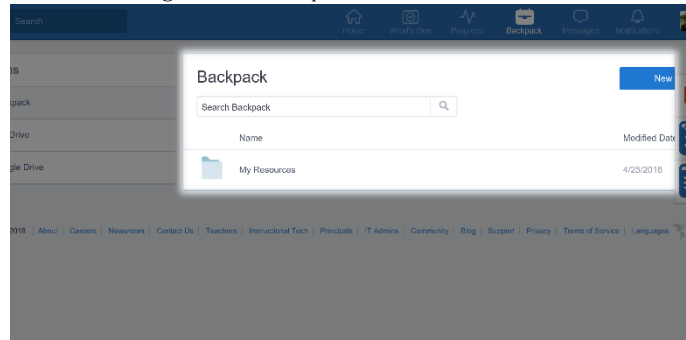


Figure-5. The Backpack in Edmodo for Students



2.1.4. Assessment

Assessment in OnALE provide avenue for evaluation on students' learning. Formative assessments are conducted in the form of quizzes and assignments, while summative assessments are conducted via the authentic task which is integrated with student's performance evaluation. In *Edmodo*, the formative assessments are conducted using the *Assignment* and *Quiz* function as depicted in Figure 6 and Figure 7.

Figure-6. The Assignment in Edmodo

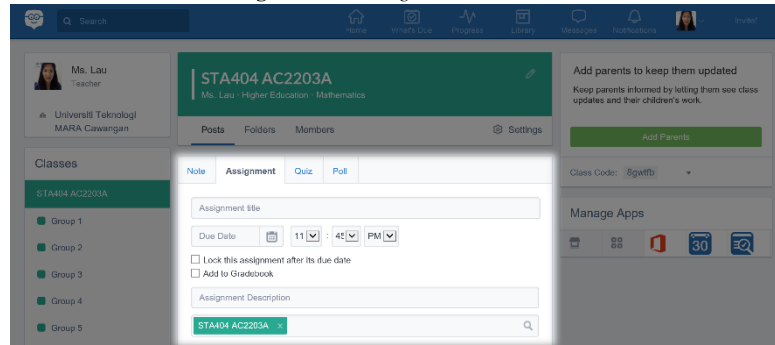
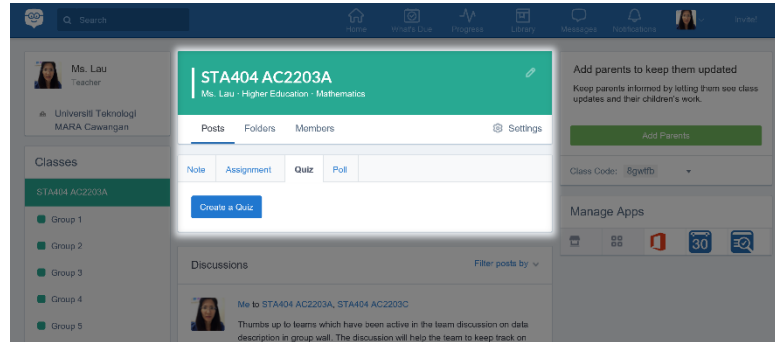


Figure-7. The Quiz in Edmodo for Instructor



2.1.5. Support

Support is also an important component in OnALE to offer learners assistance to develop learning skills and moving towards independent learners. OnALE offers two types of supports: learning support and technical support. In *Edmodo*, students can make use of the forum to get learning support from peers or direct message their instructor as illustrated in Figure 8. Those encountering technical problem can use the same means to get support or they can make use of a dedicated technical support offered by *Edmodo* Support Center as shown in Figure 9.

Figure-8. The Direct Message in Edmodo

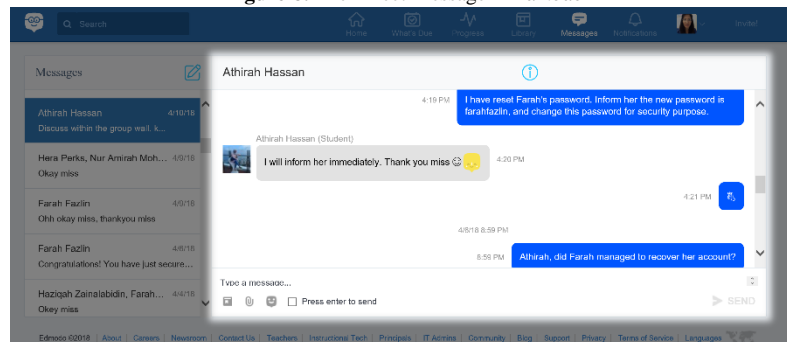
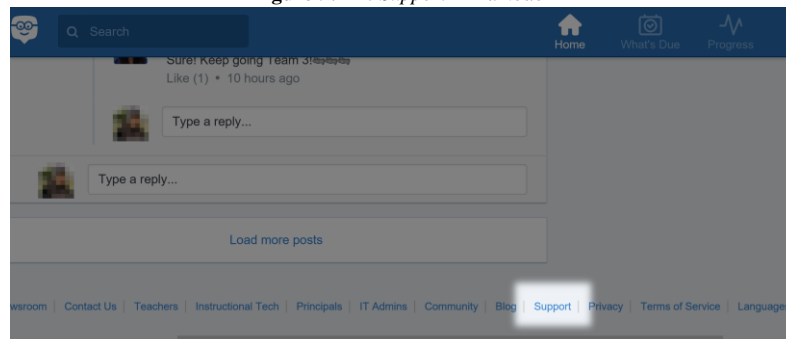


Figure-9. The Support in Edmodo



2.2. Implementation of Authentic Learning in OnALE

The following subsections describe how the nine characteristics of authentic learning are embedded in OnALE in delivering real-life contextual inferential statistics course for non-statistics major students.

2.2.1. Authentic Context

In authentic learning, knowledge needs to be presented in the context that reflect the way the it will be used in real-life. In OnALE, the environment where inferential statistics is used in real-life is simulated. A conversation via

email message between instructor and students is initiated to start negotiation for a project. For the project, the students collected the data required online and performed the data analysis using the statistical software, just as what an applied statistician would do.

2.2.2. Authentic Task

An authentic task need to have world relevance, where problems are ill-defined, involve collaboration among team members and require a substantial amount of time to investigate. In OnALE, the authentic task is presented as project to be worked in groups of 4 members each. The project titled *Online Business Rangers* requires the learners to take the role as an online businessman to apply inferential statistics to make business decision (detail of the project is presented in section 2.3). The project is to be done in a 10-week period.

2.2.3. Expert Performances and the Modelling of Processes

Having access to expert performances and modelling of process in authentic learning allows peripheral learning. The learners first observe how the task are handled by professionals before attempting the task by engaging the similar approach. Often, those who has recently acquired the knowledge or skill are the ones in the best position to share the knowledge and to remedy on the misconceptions that might be hindering understanding.

The group in OnALE consists of members of different performance levels. Each group are also assigned one student who have taken the course previous semester acted as the senior executive for the business company that the students worked for in the project. This is to allow the group to get different views from learners from different level of expertise. Videos of statistician explaining how to perform certain analysis are also posted by instructors for peripheral learning.

2.2.4. Multiple Roles and Perspectives

A single perspective is inadequate for authentic learning because a single experience does not equal expertise. Learners need to have different perspectives on a matter from various point of views and roles.

Every students were given opportunity to express opinion from their perspective in the discussion forum in OnALE. Learning materials are also presented from multiple resources. The posting wall that keeps the records of group discussion and learning materials posted in chronological order allows the learner to crisscross the learning environment and resources and revisit the same material at different time to get different perspective.

2.2.5. Collaborative Construction of Knowledge

Knowledge is developed through social interaction (Churcher, 2014). Collaboration among learners in groups foster this kind of interaction. The learners will not only work together but also developing skills or creating a product which could not have been achieved alone. Collaboration is also viewed as important as enabler for other characteristics of authentic learning such as coaching and scaffolding.

The task in OnALE is a group project work of 4 members team. They are evaluated for group project report apart from individual self-reflection report. This provide motivation for the students to work in group. The use of the discussion forum in OnALE allows the group members to collaborate rather than cooperate to complete their task. Sharing of learning materials among the learners in OnALE are also possible via the link or document attachment function in the post.

2.2.6. Reflection

Meaningful reflection is emphasised in authentic learning because learners will gain new understanding and appreciation when they revisit their experiences.

The task given in OnALE are not well-defined and students needed to decide and define what subtask to be done along the process. This decision making process provide inherent opportunities for students to reflect on their learning as they progress. Discussion in group enable the students to compare their thought with others to reflect upon. The resources in OnALE are also not presented in linear form to encourage the students to move freely in the learning environment and readily return to any resource to reflect when necessary.

2.2.7. Articulation

Vygotsky (1978) believes that the act of creating the speech greatly influences the learning process. The process of articulating a communication among learners enables construction, awareness, development, and refinement of thought.

In OnALE, the students are required to produce a report to present their findings for the project assigned. The students needed to put in words their justifications or arguments for the interpretation made in the inferential analysis. Even before coming to consensus within the group members, each member will need to voice their opinion with argument in the forum.

2.2.8. Coaching and Scaffolding

Based on Vygotsky (1978) Social Development Theory, a learner when assisted by more knowledgeable others, will be able to achieve higher skill than what the learner is capable to do on ones own. This makes coaching at critical times and scaffolding support important especially in online authentic learning.

The collaborative learning in group in OnALE allowed more knowledgeable students to assist with coaching and scaffolding among peers in need. The instructor is still available for assistance where the student can direct messaging their instructor when none the group members are able to provide feedback to resolve an issue.

2.2.9. Authentic Assessment

Assessment affect the way students learn. Using conventional assessment for a constructivist learning environment may not indicate effect of the quality of the learning on the learners. An authentic assessment with assessment embedded to the learning is needed.

Assessment in OnALE was seamlessly integrated with the activities of the task. Performance of the students is assessed based on the project work done and there is no other separate test to assess students learning from the project. There are multiple indicators of learning used in OnALE, where students not only assessed on the inferential analysis done, but also on the group written report and self-reflection report.

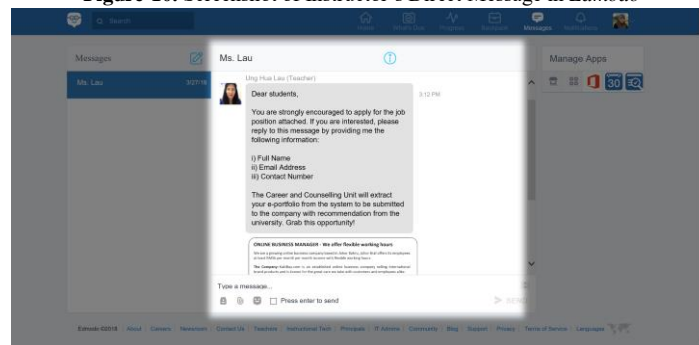
2.3. Project Task Execution

The task in OnALE is carefully planned in its execution to ensure the manifestation of the characteristics of authentic learning in OnALE for inferential statistics learning. The execution of the task are divided into three sequentially arranged phases; the beginning, developing and concluding phases. The following subsections describe the execution of the *Online Business Rangers* project to depict these sequential phases in presenting the tasks authentically to the students.

2.3.1. Phase I: Beginning

At the beginning phase, students were introduced to the problem in a situation. The instructor sent a direct message in *Edmodo* to every students to advertise job of an online business manager. They are requested to send in their personal particulars for the job application by replying to the message.

Figure-10. Screenshot of Instructor's Direct Message in *Edmodo*



A few days later after upon providing the information, the students to receive notification of the successful job application and are assigned a group for team work. The (made-up) company representative cum senior executive in the company then posts a welcoming note in the group wall and reveals the task. The group task is to investigate buyers online satisfaction and purchase intention in 10-week duration. The students are allowed to get assistance from the senior executive of the company if they require professional advice.

Figure-11. Screenshot of Instructor's Notification via Direct Message

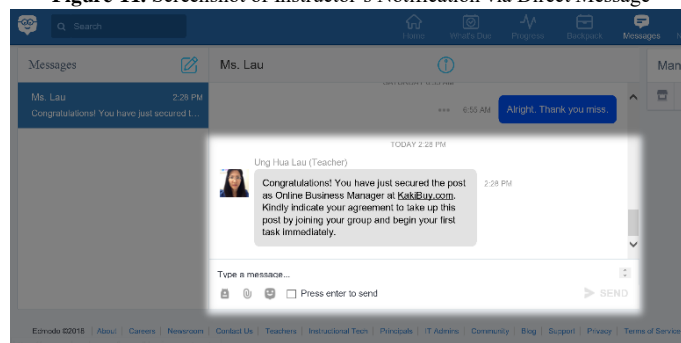
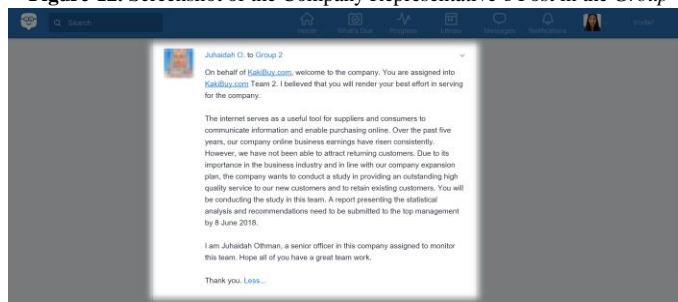


Figure-12. Screenshot of the Company Representative’s Post in the Group



2.3.2. Phase II: Developing

In the developing stage, the students generally used the forum in *Edmodo* for discussion. However, cues to get students to move from one subtask to another subtask are made by the instructor. This cues are conveyed to the students via the class wall.

For each of the component covered, the students need to make decisions. For that, they are required to discuss in group and make group decision with justifications based on statistics knowledge.

2.3.3. Phase III: Ending

For the concluding phase, the students are to write an individual report for the project in MS Word document. The company representative reposted the assignment post to remind on the deadline of report submission and the guidelines for report. The student submitted the report via the assignment center.

3. Results and Discussion

An undergraduate class consisting of 41 first year non-statistics major students from a public university in Malaysia was taken in a perception survey on OnALE. These students enrolled in *Statistics for Business and Social Science* course in semester March – July 2018 and had undergone OnALE implemented in their project component of their coursework for that semester.

After 10 weeks engaging in OnALE and upon submission of their project report, students were given a validated perception questionnaire to gauge their perception on the use of OnALE in assisting their learning. The questionnaires consists of 9 constructs for each of the critical authentic learning characteristics, with at least 4 items in each construct. The rating score was taken on 5-point Likert scale from the least, 1 for *Definitely disagree* and maximum of 5 for *Definitely agree*.

Figure 13 presented the mean scores obtained for each of the critical authentic learning characteristics. To interpret this mean scores, the researcher adopted the mean range interpretation using natural boundaries of the numbers anchored on the scale proposed by [Pornel, Balinas and Saldaña \(2006\)](#), where 0.00 – 1.49 range is for *Definitely Disagree*, 1.50 – 2.49 for *Mostly Disagree*, 2.50 – 3.49 for *Half Agree*, 3.50 – 4.49 for *Mostly Agree* and 4.50 – 5.00 for *Definitely Agree*. This scheme has more than 90% efficiency in estimating the respondent’s true latent ability that is being measured by the scale, as opposed to the most common but flawed way to determine the mean range by employing equal width for each interpretation categories ([Pornel and Saldaña, 2013](#)).

All the means generated are at least 3.49, with the highest 3.79. This shows that, except for *Multiple Roles & Perspectives*, all the students mostly agree that the authentic learning characteristics in OnALE assisted their learning. *Authentic Assessment* in OnALE scored the highest. This finding is expected because assessment is profoundly effecting how students learn. The authentic assessment which seamlessly integrated with the activity encourages the students to evaluate what they have learnt. However, *Multiple Roles & Perspectives* in OnALE does not score better than the rest, possibly due to the conventional education system that promote learning by discipline and switching into learning in multidisciplinary approach takes time, especially when the benefits were not experienced by the students during the formal learning period.

Figure-13. Scores of Students’ Perception on Authentic Learning Characteristics in OnALE

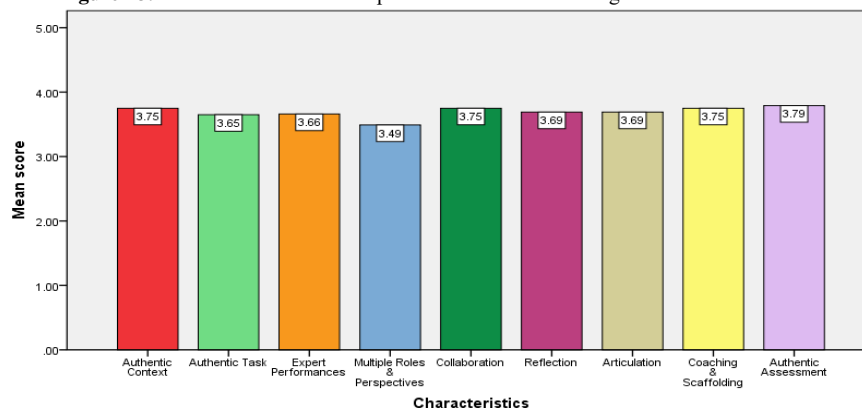
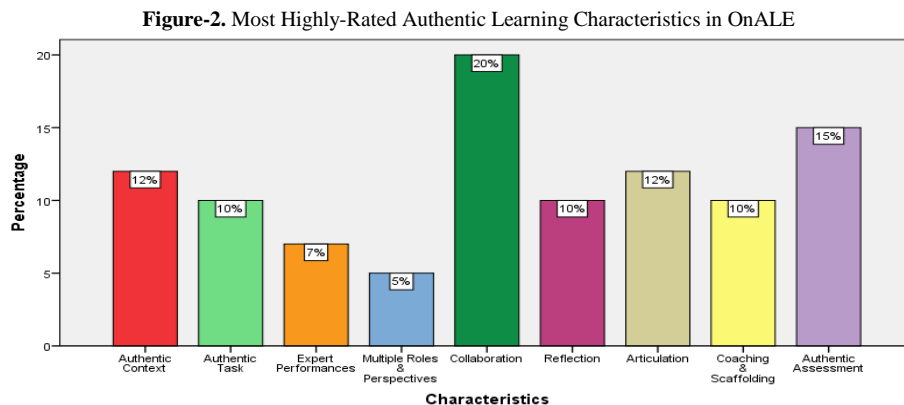


Figure 14 illustrates the percentage of students who rated highest a particular authentic learning characteristics in OnALE. Most students rated *Collaboration* with the highest score. This indicates that OnALE does support collaborative construction of knowledge as intended. Least students gives highest score for *Multiple Roles & Perspectives*. This result resonated with the earlier analysis where students scored this characteristics the lowest from all other characteristics.



4. Conclusion

The design and development of the online authentic learning environment in this study is intended for non-statistics major students to learn inferential statistics. It exposed the students to experience learning in setting similar to real-life through social interaction among peers. The use of instructional and learning model has systematically guided the researcher to incorporate elements of authentic learning in *Edmodo* to produce OnALE. Students using OnALE perceived OnALE as assisting their learning. Further empirical study can then be conducted to investigate the effectiveness of OnALE in facilitating students' knowledge construction in learning inferential statistics.

Acknowledgement

The authors would like to thank the Universiti Teknologi Malaysia (UTM) and Ministry of Education (MoE) Malaysia for their support in making this project possible. This work was supported by the Research Grant Scheme (R.J130000.7810.4F924) initiated by UTM and MoE.

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