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An Evaluation of the Udacity MOOC based on Instructional and Interface Design Principles

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Abstract. Since the first appearance of the Massive Open Online Course (MOOC), the problem of low completion rates in MOOC has often been an object of research in terms of the instructional design and interface design. However, in-depth studies that examine the implementation of instructional and interface design principles in learning on the MOOC platform are still limited. Therefore, the purpose of this study is to find out the extent of Udacity in applying those principles from the Indonesian perspective. This study also aims to evaluate the usability of the MOOC platform. There are 228 participants in this study from various regions in Indonesia. The study findings indicate that Udacity has been successful in implementing content, interactivity, and course design, but there is still room for improvement in terms of instructor presence. Some usability problems were also found, and most of them are related to the online discussion forum. This study also offers an alternative design and recommendations to tackle the problems.

1. Introduction

Massive Open Online Course (MOOC) is one form of online learning. MOOC is an online learning system that can be used by unlimited participants and can be accessed openly through the web [1]. The idea of MOOC has continued to grow so rapidly that New York Times claimed 2012 as "The Year of MOOC" because of the appearance of many big MOOC platforms, such as Coursera, EdX, and Udacity [2]. Udacity, one of the big MOOC which appeared in 2012, was a for-profit MOOC platform that focused on teaching and learning in technology [3].

In Indonesia, there are also several MOOC platforms, such as Flexible Learning Innovation Program (FLIP) SEAMOLEC, MOOCs Universitas Terbuka, and IndonesiaX. However, the number of classes offered in these MOOCs is far fewer than the number of those offered by international MOOCs [4]. According to the database of IndonesiaX, the people who have completed the course and taken the final exam phase are only 9.6% and those who have taken the final exam are only 7.6% [4]. This low completion rate is correlated with the motivation of the students taking the courses [5].

Many researchers suggest that interaction design is one of the factors that affects student motivation in completing courses in MOOCs. Course design and its implementation comprising course content, course structure, and forms of delivery are affecting student retention [6]. The instructional design also has an effect on student motivation and learning [7, 8]. Many researchers also suggest that with regard to the massiveness of MOOC, a different instructional design is needed [7-10]. Usability is also affecting student learning effectiveness and an overall learning experience [11]. The study [11] compares usability in three different MOOC platforms which are Coursera, Udacity,

and EdX. However, there are no studies that examine in depth the implementation of the instructional design and interface design in learning in certain MOOC platforms. Studies [7-10] observe the factors that affect student motivation in learning in MOOC. Meanwhile, [11] compares the usability of three different MOOC platforms using SUS.

This study is guided by following research questions.
1. To what extent instructional and interface design principles have been applied in Udacity?
2. What are recommendations for Udacity website based on instructional and interface design principles?

Udacity is chosen because the result from study [11] shows that Udacity has the lowest SUS score as compared to other MOOCs. This study of Udacity focuses on the instructional and interface design aspects. The theories used for the instructional design are Gagne's Nine Events of Instruction and Chickering and Gamson's Seven Principles of Good Practice in Online Teaching, and Shneiderman's Eight Golden Rules for the interface design. The result of this study can be used as references for other MOOC providers to create one that suitable for Indonesian people.

2. Literature review

There is some literature used in this study, namely Massive Open Online Course (MOOC), Udacity, instructional design, interface design, and usability.

2.1. Massive open online course

The Massive Open Online Course or commonly called MOOC is a form of organizing online learning with unlimited participation that can be accessed openly through the web [1]. MOOC is generally divided into 2 types namely CMOOC and xMOOC. CMOOC is a type of MOOC based on connectivism learning theory, whereas xMOOC is a type of MOOC based on a cognitive theory of behaviorism learning [5]. Video presentations, text readings, and ratings automatically are dominant in xMOOC [12]. Udacity is an example of xMOOC. The rapid development of MOOCs in recent years has made these MOOCs compete with one another for similar customer segments [13]. The performance of a platform is influenced by the ecosystem of that platform. In the case of the MOOC ecosystem, the value proposition offered comes from the MOOC platform itself and its partners [13].

2.2. Udacity

Udacity is a for-profit MOOC developed by Sebastian Thrun, David Stavens, and Mike Sokolsky in 2011 [3]. Udacity started with an experiment conducted by Sebastian Thrun and Peter Norvig with an online course entitled "Introduction to Artificial Intelligence". The course was attended by more than 160,000 people from more than 190 countries [3]. In early 2014, Udacity changed the concept from teaching university-level courses to training students for careers in technology companies [14]. The courses provided at Udacity are in computer science and are divided into several categories namely School of Programming, School of Artificial Intelligence, School of Cloud Computing, School of Data Science, School of Business, and School of Autonomous System [15]. Udacity provides two types of courses that are free and/or paid. The paid course is called Nanodegree. The main differences between the Nanodegree and the free course besides the fees are the presence of a mentor to guide the students and a project reviewer to give feedback for the submitted task. However, the class used as the object in this study is a free class on Udacity.

2.3. Instructional design

Instructional design is defined as the design of an instructional system, namely an arrangement of procedures and materials for conducting learning [16]. The quality of the instructional design used by MOOC certainly affects the quality of student learning [8]. In this research, instructional design

theories that will be used as a foundation are Gagne's Nine Events of Instruction and Chickering and Gamson's Seven Principles of Good Practice in Online Teaching.

Gagne's Nine Events of Instruction follows the instructional design process through a behaviorist approach [16]. There are nine stages comprising the time learners want to start learning to the application of learning material obtained. The following are the nine stages: gaining the attention of the students, informing students of the objectives, stimulating recall of prior learning, presenting the content, providing learning guidance, eliciting performance (practice), providing feedback, assessing performance, enhancing retention, and transferring to the job.

In 1987, Chickering and Gamson proposed seven best practices in classroom learning, but these seven principles can also be applied to online learning [17]. These seven principles, when applied to online learning, succeed in increasing the success of teachers and students [17]. In the case of xMOOCs such as Udacity, some consideration is needed whether the principle is in accordance with the course being studied and the expected learning outcomes [18]. The seven principles are: encourage contact between students and faculty, develop reciprocity and cooperation among students, encourage active learning, give prompt feedback, emphasize time on tasks, communicate high expectations, and respect diverse talents and ways of learning.

2.4. Interface design

According to [19], interaction design is designing an interactive product to support people's daily communication and interaction. In other words, creating a user experience that can improve the way people communicate and work every day. One aspect of interaction design is interface design. In this study, Shneiderman's Eight Golden Rules will serve as a theoretical basis for analyzing a class. The eight rules are: strive for consistency, enable a user to use shortcuts frequently, offer informative feedback, design dialogs to yield closure, prevent errors, permit easy reversal of actions, internal support locus of control, and reduce short term memory load.

2.5. Usability

Usability is part of the "user experience" and refers to the convenience for users in using a product/website. Usability, in general, is ensuring that a product is easy to learn, effective when used and enjoyed by users [19]. To measure the usability of a product, usability evaluation is conducted. The usability evaluation technique used in this study is an online questionnaire that includes an e-learning usability scale, usability testing, and a contextual interview.

3. Research methodology

3.1. Research design

This research uses a mixed-method design approach. The mixed-method design is one of the research methods that combines the two methods namely quantitative and qualitative [20]. This approach is carried out so that a more thorough understanding of the problem can be gained. Quantitative data used in this study were obtained from online questionnaires. In the online questionnaire, there is an e-learning usability scale (EUS) made by Sandoval [21] which has been translated by Perdana [22]. In this study, the qualitative data were obtained from the usability testing of Udacity. The results of the usability test are mapped based on several principles namely Shneiderman's Eight Golden Rules of Interface Design, Gagne's Nine Events of Instruction and Chickering and Gamson's Seven Principles of Good Practice in Online Teaching. This study only analyzed the free course class in Udacity.

3.2. Participants

The participants in this study are people who have done online learning at Udacity. There is no age limit on the specified respondents. Respondents come from various regions in Indonesia.

3.3. Instruments

The instruments used in this study were a research questionnaire and a task scenario for usability testing. This questionnaire contains questions related to respondent demographics, open-ended questions to survey motivation and level of course completion, and EUS. The complete questionnaire can be accessed via the link bit.ly/SurveyUdacity. EUS is used to measure the usability level of an e-learning platform, in this case, Udacity. For usability testing, a task scenario was created to test how familiar the user is in learning in Udacity. This scenario task is based on the instructional design principles that form the basis of this research. There are 11 task scenarios namely: Select the class that interests you; Find an outline of learning (syllabus); Read the learning objectives and instructor profile; Search for introductory material; Select the preferred learning module and start studying it; Find the reference source link; Write a question in the discussion forum; Answer questions from the discussion forum page; Work on quizzes; Find a solution to quiz answers; Work on projects and find teacher contacts.

3.4. Procedure

First, an online questionnaire was distributed to measure face validity. Face validity was carried out with 15 people to find out what people understand when reading the questionnaire given. Then, the questionnaire was distributed massively online through various social media platforms. The incoming data were then cleansed by erasing inconsistent data. After selecting all the respondents who have learned using Udacity, 15 respondents were chosen randomly to participate in usability testing. UT is done in two ways namely face-to-face and remote-moderated UT. After identifying the usability problems, recommendations for improvement were made. These recommendations are in the form of a high-fidelity prototype. The recommendation was then re-evaluated by 8 participants who joined UT. Finally, a conclusion was drawn from the whole study.

3.5. Analysis method

Quantitative data were derived from the EUS results. A study conducted by Sandoval [21] for EUS did not include a standard score to be said to be "Good" in each group. Therefore, the interpretation of standard scores conducted in this study refers to studies by Prime [22] who used research [23], for interpretation of standard scores on a Likert 7 scale. Based on these studies, the results of each component were calculated as means, and the standard deviation was compared to the upper, neutral or lower values. If the mean is close to 7 and exceeds the neutral value (> 4.5), then the component has a positive tendency. However, if the contrary occurs, then the component tends to be negative and needs improvement.

Qualitative data were obtained from the open-ended questions in the online questionnaire and also the insights were gained from the results of the usability testing. The data were categorized using theme-based content analysis (TBCA) techniques. TBCA is a qualitative method that provides useful detailed information about user opinion or behavior and can also provide a general indication of the results of a user population by grouping them into meaningful categories [24]. There are five fundamental stages in TBCA, namely data collection, data collation, theme definition and classification, higher-order theme selection, and presentation of classification matrix.

4. Results and discussion

The total respondents who filled out the online questionnaire were 228 respondents. Most participants are college students (73.2%) or employees (14%), and aged 17-25 years old (86%). The data were then analyzed in terms of both demographics, intensity of internet usage and MOOC, and the completion rate of students taking courses on Udacity. For respondents who had used Udacity, the experience of respondents using Udacity and e-learning usability scale was also analyzed.

4.1. Completion rate of Udacity course

Regarding the use of MOOC, from 228 respondents, as many as 135 respondents have never done online learning using MOOC. The popularity level of Udacity is still quite low with only 27.2% of respondents who have heard of Udacity. The use of Udacity in Indonesia is still fairly minimal. 187 out of 228 respondents (82%) have never used Udacity, so only 41 respondents have used it. This might be related to demographics where Udacity user respondents were mostly male, while the overall respondents of this study were more female. This shows that Udacity is more popular among men. This might also be because the course at Udacity is quite specific. It only offers courses related to computer science which are indeed more attractive for men.

The reason the majority of users use Udacity is to increase knowledge (37 people), support their work (26 people) and try MOOC and challenge themselves (13 people). Regarding the level of course completion in Udacity, the majority of respondents or 61% answered that they had never completed a course (25 people). This is possible because most respondents aged 17-25 years are of productive age. Having many responsibilities, they probably do not have enough time to complete the course. The majority of the respondents, eight respondents answered that they had completed 1 course, and another eight respondents answered that they had completed 2-3 courses.

Out of the 16 respondents who have completed a course at Udacity, the majority answered their 'motivation in completing the course' was because they wanted to gain in-depth knowledge, needed that knowledge for work or education, and wanted to broaden their knowledge. Out of the 25 respondents who did not complete the course, the majority answered (20 respondents) this was because there was not enough time due to other priorities, followed by forgetting to do the activities in the course (11 respondents) and losing motivation (10 respondents).

As many as 32 respondents answered that they liked Udacity in terms of content and learning delivery, 15 respondents liked the good UI and UX design, and eight respondents liked the features available in Udacity. A total of 14 respondents said they did not like Udacity because of the price of the course for the Nanodegree class. Then, in terms of learning content, such as the delivery of material, they considered it less attractive and incomplete. Furthermore, in terms of language, they did not like Udacity because the English used was not very clear and there was no Indonesian.

4.2. Analysis of instructional and interface design application

The analysis of instructional design aspects of Udacity is based on two theories namely Gagne's Nine Events of Instruction and Chickering and Gamson's Seven Principles of Good Practice in Online Teaching. The following table gives examples of the activities and principles applied.

Table 1. The Application of Instructional Design Principles in Udacity.

Application Example	Related Principles
First Page	Gaining Attention[a]
Course Info: Learning Objectives, Instructor profile	Informing student of the objectives[a]; Encouraging contact between students and faculty[b]; Communicating high expectation[b]
Forum	Developing reciprocity and cooperation among students[b], Encouraging active learning[b]
Video introduction	Stimulating recall of prior learning[a]
Video Learning Material	Presenting the content[a]
Additional Learning References	Providing learning guidance[a]; Respecting diverse talents and ways of learning[b]
Quiz	Eliciting performance[a]; Encouraging active learning[b]
View quiz answers	Providing feedback[a]

Application Example	Related Principles
Final Project	Enhancing retention and transfer to the job[a]

[a.] Gagne's Nine Events of Instruction

[b.] Chickering and Gamson's Seven Principles of Good Practice in Online Teaching

Based on the observations, Udacity has applied all of the principles proposed by Gagne's Nine Events of Instruction and Chickering and Gamson's Seven Principles of Good Practice in Online Teaching except for three principles. The three principles are assessing performance [16], encouraging contact between students and faculty [17], and emphasizing time on tasks [17]. In the Nanodegree class, aspects of assessment performance are met by the project reviewer of each course. Encouraging contact between students and faculty is exercised through mentor facilities, and finally emphasizing time on tasks is fulfilled by applying task deadlines in the Nanodegree class. This can occur because the Nanodegree class is timed so that deadlines can be set, while the free course class has no time limits.

The application of these three principles may be related to the MOOC ecosystem of Udacity. Udacity is targeted at professionals who are able to pay a reasonably high price but only have limited time to study. Thus, Udacity is developing its Nanodegreen programs more than its free courses.

The aspect of the interaction design observed in Udacity refers to Shneiderman's Eight Golden Rules theory. Udacity has applied all aspects of the principles, but the principle of striving for consistency still needs to be improved. This is due to differences in design between the Udacity page and the discussion forum page on the course. On the Udacity page, Udacity uses a lot of shading and color gradation effects which are dominated by blue. On the other hand, the forum page looks very plain with only black and white and flat design.

4.3. Analysis of Udacity usability
Usability of Udacity was assessed using two instruments namely EUS contained in the online questionnaire, and usability testing. The results of the EUS of each group are described in the following table.

Table 2. EUS Result of Udacity (n = 41).

Group	Number of Instruments	Mean	Standard deviation
Content	9	5.77	1.17
Interactivity	6	5.73	1.14
Instructor Presence	3	3.89	1.29
Course Design	9	5.78	1.17

From the table above it can be seen that the average group of statements other than Instructor Presence has a considerably high value of above 5.70. This shows in terms of content, interactivity, and course design, Udacity has met the standards of measuring devices. In terms of content, Udacity is good at presenting learning objectives, modules, and learning materials. In terms of interactivity, Udacity is also good, namely in terms of an interaction between students and learning for example quizzes, assignments and self-reflection. Finally, in terms of course design, Udacity is good at presenting interesting and easy-to-use learning material. However, in terms of instructor presence, Udacity still has room for further improvement, such as the interaction between students and instructors.

The results of usability testing conducted on 15 people with 11 task scenarios indicate that Udacity still has some problems related to usability. The problems were then analyzed based on the number of people who have experienced them and then grouped according to the level of urgency. The level of urgency of the problems is divided into three, namely high, medium and low. The following is an explanation of this.

The below table summarizes the problems encountered while conducting usability testing. Frequency shows how many people encountered the problem.

Table 3. Usability difficulties encountered after conducting UT (n = 15).

Problem	Frequency
Difficulties finding button redirect to the discussion forum page	10
Instructor profile that is not complete	6
Learning objectives are not visible enough	6
There's no information about the class after entering the class	6
People thought "send feedback" button is a button to the discussion forum page	6
Filter function that not adequately visible	5
Video fills the entire screen so people thought there are no additional resources	4
The quiz answer box doesn't match the design quiz so some people are confused by where to answer	4
Thought that the button to the forum is in course home page same as another MOOC	3
Difficulties in seeing detailed learning progress	3

4.3.1. High urgency rate. Problems included in this category are problems experienced by 8-15 participants (> 50%). These problems also hinder the application of instructional design principles that are used as a reference in this research. One of the problems that falls into this category is the difficulty of finding the button to the discussion forum page experienced by 10 participants. The 10 participants consisted of both personas. This difficulty occurred because the button to the discussion forum page was in the "resources" tab. Respondents felt the word "resources" did not refer to online discussion forums. This problem may be related to the low value of EUS in the instructor presence aspect. This is because in the free course, the discussion forum is the only means for students to connect with the instructor so that even when a user is having trouble finding a forum, he or she cannot communicate with the instructor and the desire to ask the instructor disappears.

4.3.2. Medium urgency rate. Problems included in this category are problems experienced by 4-7 participants. These problems do not really impede the application of the instructional design in learning, but it would be very helpful if the problems were solved. The problems that arise from various pages are the filter function that is not adequately visible, the teacher's profile which does not provide any explanation, learning objectives that are not visible enough. There is no information about the course when entering the class and the send feedback button is thought to be a forum. The videos on the courseware page also fill the entire screen, so some participants didn't realize the additional

resources. And the quiz answer box does not clearly visible because of mismatched design, thus confusing some participants.

4.3.3. Low urgency rate. Problems included in this category are problems experienced by 1-3 participants. The problems that are included in this category are only additional and removing them will increase user satisfaction in using Udacity, but they do not hamper the implementation of the instructional design. Examples are difficulty in finding buttons to a page and difficulty in seeing the progress of learning

5. Recommendations
Based on these problems, several recommendations for improvement related to the existing problems are given.

5.1. High priority recommendation
Recommendations for fixing the problem of difficulty in finding the button to the discussion forum consist of two things. The first is the placement of the discussion forum button on the course home page. This is because users are more familiar with this position because other MOOCs like EdX, Coursera and FutureLearn place their forum page in the course home section. Secondly, the forum button will be moved to the button at the top right of the courseware section and will be given a striking button color. These improvement recommendations relate to the instructional design principles of developing reciprocity and cooperation among students and encouraging active learning [17]. The following figure shows an example of these recommendations for improvement.
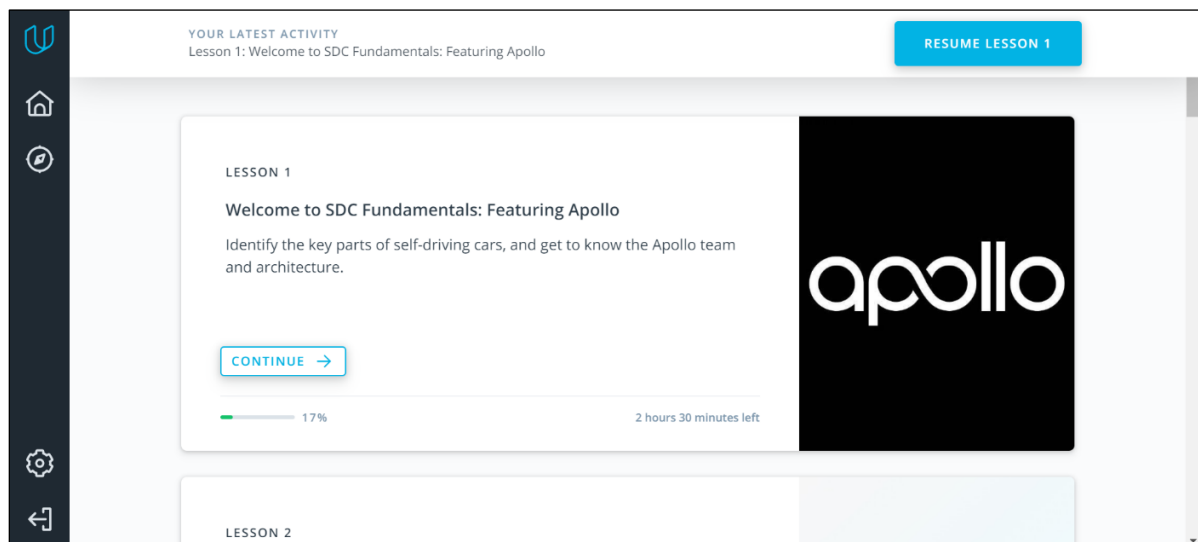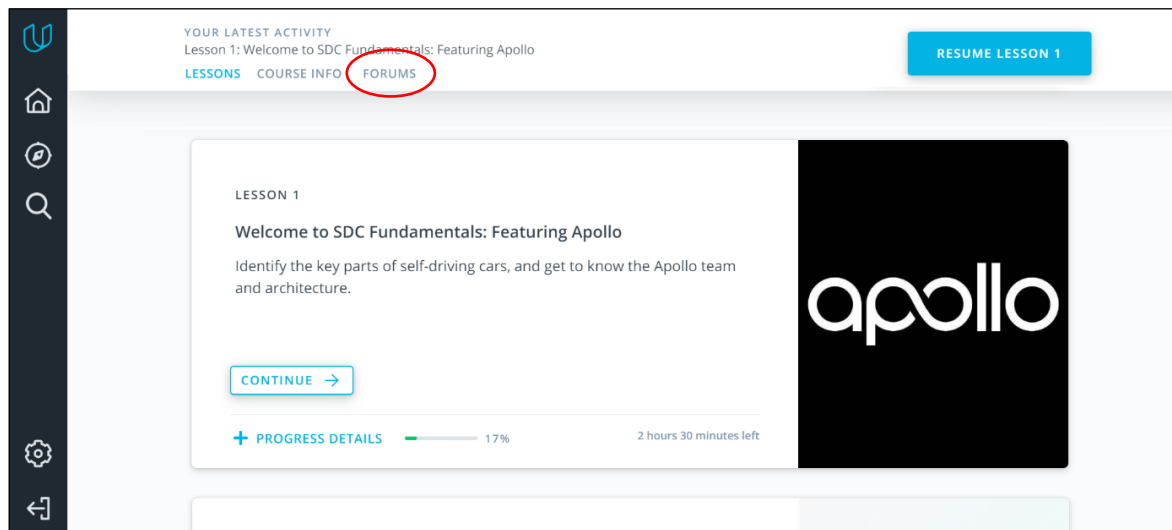

Figure 1.Previous course home page.

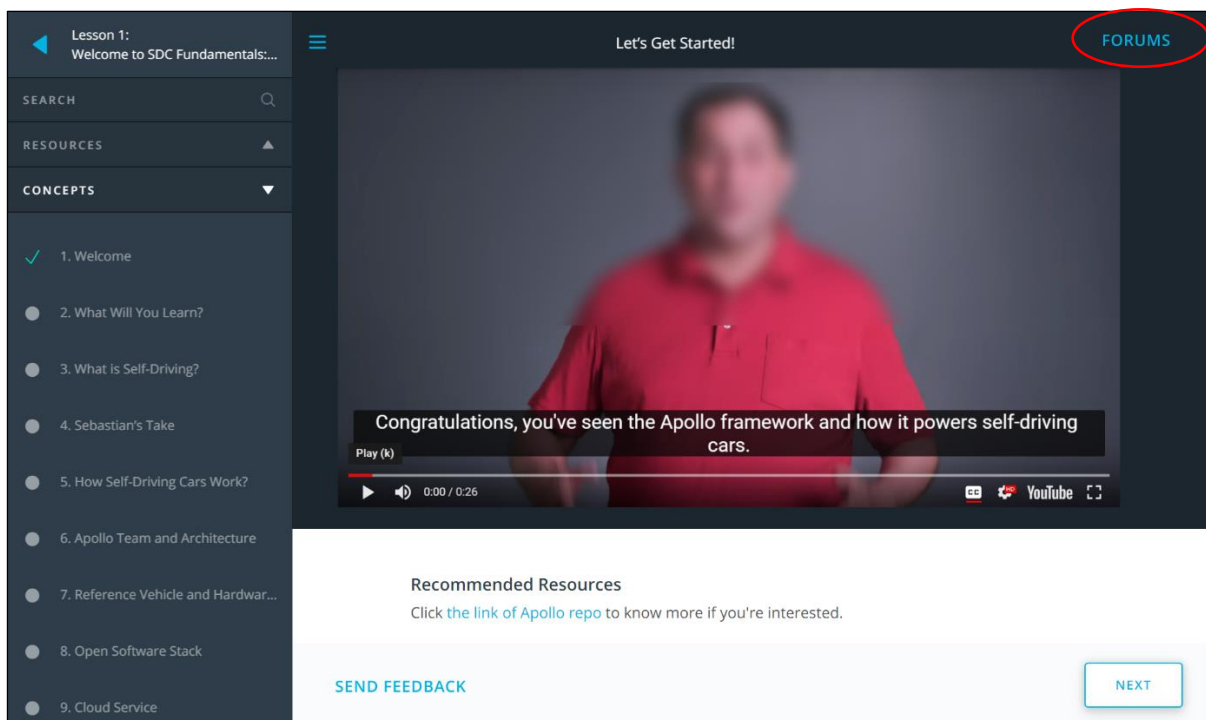**Figure 2**. Add forums button on the course home page.

Figure 3. Add forums button on the course home page.

5.2. Moderate priority recommendation

Recommended improvements for this moderate level include moving the filter to the bottom of the search bar so that it is more visible. Other recommendations are to provide a complete teacher profile and explicitly state the learning objectives in bullet points. This relates to the principle of informing students of the objectives [16] and communicating high expectations [17]. Another recommendation is to reduce the video size so that it does not fill the screen and additional references below are visible. For problems related to quizzes, a tooltip that reads "answer me" to indicate where to answer should be added. The following is an example of changing the location of the filter to make it more visible.
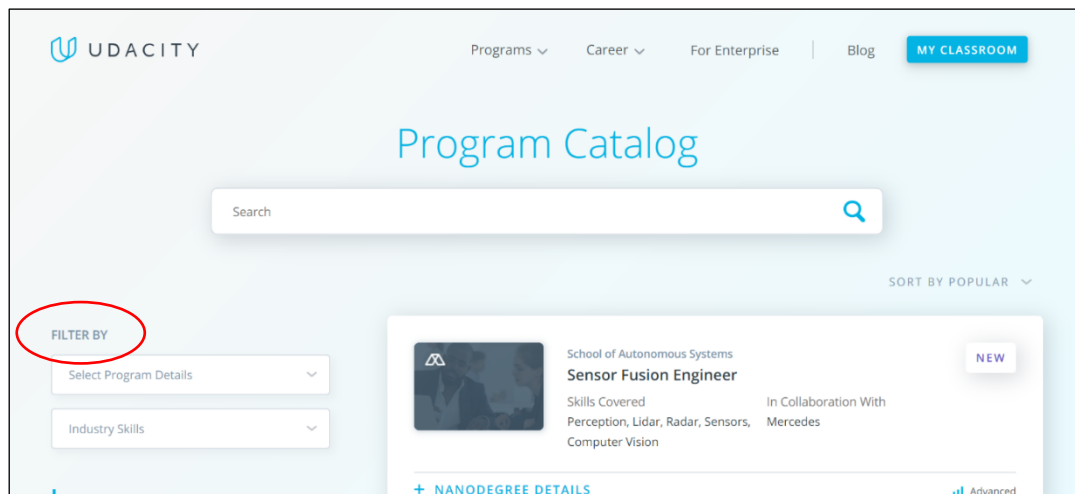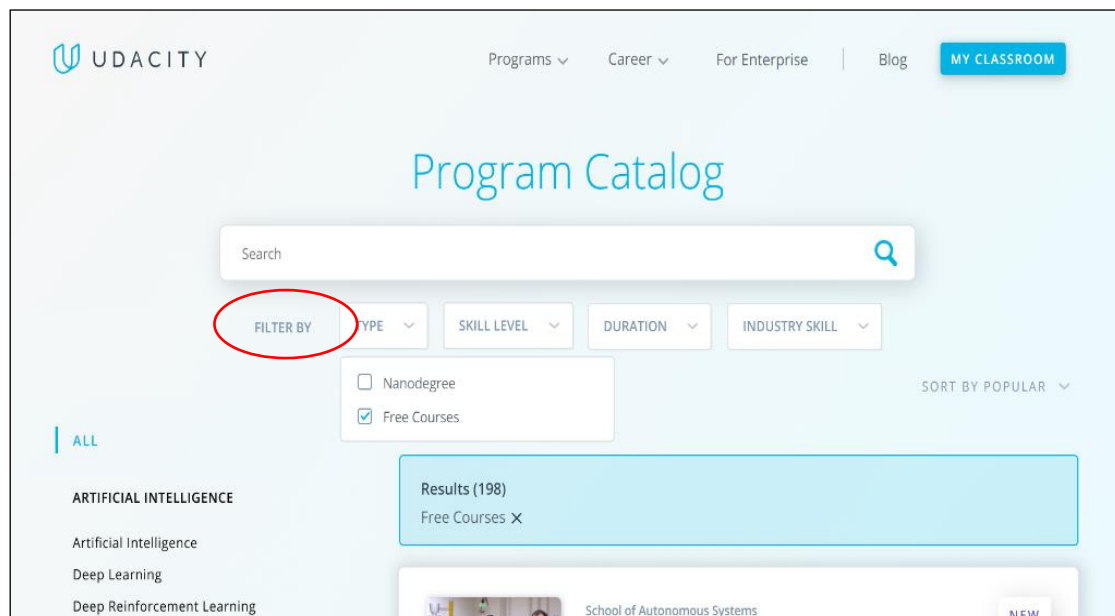
Figure 4. Previous program catalog page.

Figure 5. Filter on page for a catalog program.

5.3. Low priority recommendation

The improvement recommendations for this urgency level are only in the form of additions so that the user experience in using Udacity is increasing. Examples of recommendations for improvement are adding a few buttons, such as the search bar button on the MyClassroom page and the forum button on the Course Home. Other recommendations are adding additional information, such as course duration and estimated time per week, as well as adding a progress bar on the dashboard page for each course, and also a progress bar detail for each lesson. This progress bar is related to metacognition theory [24] which can increase user interest in online learning. The following is an example of progress on the course page.
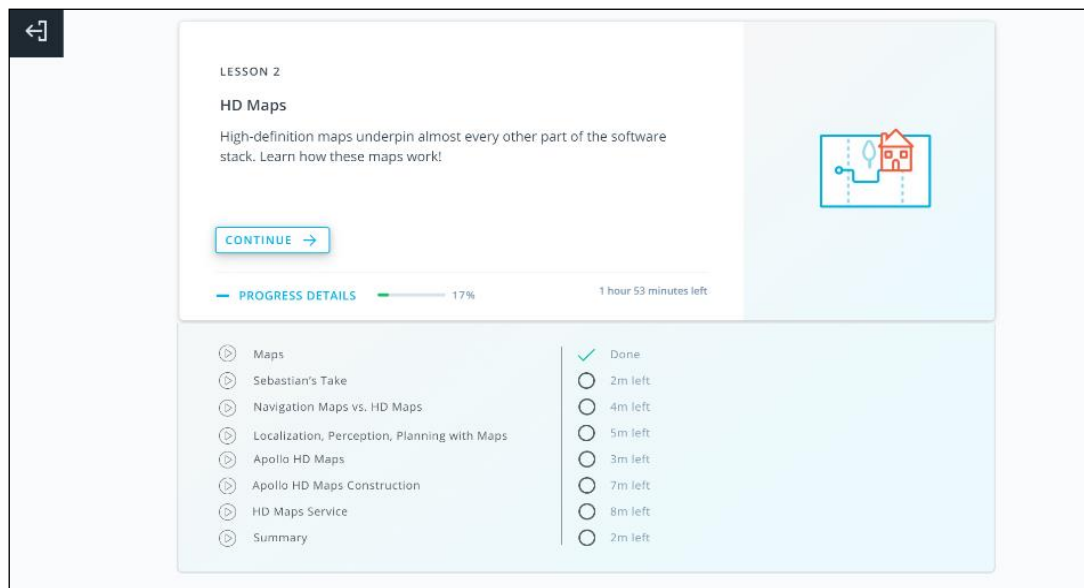
Figure 6. Detailed progress on the course page.

5.4. Supplementary recommendation

Recommendations for improvement in this section are recommendations for improvements that are additional or outside the usability problems experienced. The first improvement recommendation offered is related to the low value of teacher attendance at EUS. The majority of interviewed respondents felt that they did not have any problems related to this because the course they took was free and not limited in time. The suggestion they offered was providing a feature for sending messages to instructors privately via the course page. Another suggestion was to encourage students to ask questions and provide active moderators on the forum page to trigger or answer questions. The second improvement recommendation was providing Indonesian subtitles in the learning video so that it will be easier for users who do not understand English well enough.

Alternative designs that have been made were then re-evaluated. The evaluation was carried out in the form of contextual interviews with recommendations for improvements implemented. From this evaluation, insight would be explored to see whether the solution was successful in overcoming the problems that occurred before. The result was that all recommendations have succeeded in helping the users except for two recommendations for improvement that were only partially successful and are elaborated in the following table.

Table 4. Evaluation of the recommended solution.

Partially Successful Recommendations	Recommended Solutions
Reduce the size of the video so that it does not fill the screen leaving a little white space below it for additional references.	Provide white space and a short text so that the user realizes that this space still has a continuation or provides an arrow button at the bottom of that space which can be clicked to immediately display a reference below.
Design the answer button to make it look prominent and add a tooltip labeled "answer me" to indicate where to answer the quiz.	Add a description in the middle of the video with instructions on where to place the answer to the quiz.

6. Conclusion and further research

This study aims to find out the extent of Udacity in applying instructional design and interface design principles from the Indonesian perspective. This study also aims to evaluate the usability of the MOOC platform and give recommendations about it. The course analyzed in this study is the free one.

E-learning usability scale results show that in terms of content, interactivity, and course design, Udacity has achieved a considerably good score. However, in terms of instructor presence, Udacity is still significantly lacking. This is likely due to the fact that these are free and self-paced courses so there is no fixed learning period. Because the time period is not fixed, there are no important dates for assignments and there is no direct interaction between instructors and students.

In terms of instructional design, Udacity has applied most of the instructional design principles except for the principle of assessing performance, encouraging communication between students and teachers, and emphasizing time on tasks. This may be related to the MOOC Ecosystem of Udacity. Udacity targets professionals who want to develop their careers. Those in this market target certainly have more money than ordinary students. Therefore, Udacity is more focused on developing the Nanodegree class than the free courses.

Meanwhile, in terms of the interaction design, Udacity has applied seven of the eight golden rules. However, it needs to improve on the principle of striving for consistency because there are still several pages with different structures between courses and discussion forum pages that apply different design guidelines from Udacity.

In terms of usability from Udacity, the qualitative data obtained from usability testing shows that there are some usability issues in Udacity. Most problems occur on the online discussion forum page. Therefore, recommendations for the improvement of existing problems are related to the principles of interface design and instructional design.

The results of the evaluation of improvement recommendations indicate that the majority of the suggested improvement has successfully solved the existing problems. However, two problems have only been partly overcome, namely the difficulty in finding the place to answer the quiz and additional sources of references that are not adequately visible. However, most of the recommendations for improvement could be used as a solution to solve the usability problems that exist in Udacity.

There are several limitations in this study, namely the object used in this study which is only a free course class on Udacity. Thus, for further research, analysis can be done for the Nanodegree class, which will, of course, produce different results. The analysis conducted in this study was also carried out by the author, who is not an expert so that in subsequent studies, the analysis could be done using expert judgment by an expert so that the results of the analysis are more valid.

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