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# Method of Creating Story-based Lectures from a Past-to-present Perspective that Helps Non-Technical Adult Learners Understand AI

Keisuke Seya*
Graduate School of System Design and Management, Keio University

Nobuyuki Kobayashi
The System Design and Management Research Institute of Graduate School of System Design and Management, Keio University

Seiko Shirasaka
Graduate School of System Design and Management, Keio University

**ABSTRACT**

As emerging technologies are rapidly spreading, the demand for emerging technology education is growing for both technical and non-technical people. Previous study has shown the effectiveness of a story-based, visual and agile teaching method for non-technical adult learners, but it did not clarify how to make effective stories. The purpose of this study is to propose a method of creating story-based lectures from a past-to-present perspective and to show the effectiveness of the method over non-technical adult learners in terms of improvements in test scores and post-lecture satisfaction. For the evaluation, we created a history-based lecture by the proposed method and provided a basic Artificial Intelligence (AI) course to non-technical adult learners. Effectiveness was measured by a favorability rating of the history-based lecture and by the overall satisfaction at the end of the course; the reasons for those ratings were also gathered. The learning performance was measured by knowledge tests. The novelty of this study lies in the clarification of one effective method of creating a story-based lecture for non-technical adult learners who want to learn AI and identifying the reasons why this method works.

Keywords: teaching method, storyline, artificial intelligence, adult learners.

## 1. INTRODUCTION

Digitization is taking place in every industry around the world and emerging technologies such as Artificial Intelligence (AI) are impacting our lives more than ever. Seya et al. (2019) have shown the effectiveness of a story-based, visual and agile teaching method for non-technical adult learners who want to learn Artificial Intelligence. However, the beneficial characteristics of such stories and the method of creating them is not clear.

The purpose of this study is to propose a method of creating story-based lectures from a past-to-present perspective and to show the effectiveness of the method over non-technical adult learners in terms of improvements in test scores and post-lecture


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satisfaction. One of the reasons why beginners face difficulties in learning new technology is because they do not have sufficient confidence in whether they are heading in the right direction with the given learning material (Wang et al., 2018). This situation is more pronounced for beginners learning AI. Because AI comprises several disciplines such as classical machine control, inference, expert systems, machine learning, deep learning, and various other technologies, elements get intricately entangled, making it difficult for beginners to see how each discipline is connected. As a result, it becomes difficult for learners to locate themselves on the learning path.

In order to alleviate such a challenging learning experience, we propose a method for creating a story-based lecture by reconstructing learning topics in chronological order by referring to history (referred to as "linearization" in this study). With this method, in order to linearize a complicated story about the subject, the story is reconstructed by learning about the subject's own history. The reason we use history is simple. In the first place, history is essentially linear, and the elements that make up the story of history are often related to each other for some clear reason, so the reason to learn such related-elements would be clear on its own if we use a history-based story for a lecture.

The evaluation method of this study was first to build a basic AI course constructed for non-technical adult learners using the proposed method, and then to provide the course to non-technical adult learners. During the course, we tracked knowledge test scores for each participant before and after a specific lecture to see the learning performance outcomes of the lecture in terms of the magnitude of the change in their knowledge about the topic. After the course, we also measured how much the participants liked the style of the lecture designed by the proposed method and gathered the reasons why they liked it. In addition, we measured participant satisfaction with the course by Net Promoter Score (Reichheld, 2011) and analyzed the reasons why they were satisfied with the course after the course was finished.

The open coding analysis of the evaluation results suggests that the history-based lecture helped learners to understand topics, provided entertaining lectures, piqued learners' interest, and helped them acquire useful practical knowledge. It is also suggested that the course built by the proposed method could solve six issues (Wang et al., 2018) that conversational programmers face (conversational programmers are a class of learners who are not required to write any code at work, but try to learn programming to improve their participation in technical conversions (Chilana et al., 2015, Chilana, Singh and Guo, 2016, Wang et al., 2018)).

While the level of learners’ knowledge changed a lot in terms of the test score differences before and after the lecture, we found there was only a weak correlation between the learners’ test scores and learners’ satisfaction after the course. This suggests that factors other than the test score might also be affecting satisfaction. This aligns with findings in other studies (Sockalingam, 2013, Wu, Hsieh and Lu, 2015) which show other influencing factors on learning satisfaction, such as course content and administrative service experience.

Studies on effective and efficient teaching methods for advanced technologies like AI have mainly concerned technical people (Seya and Shirasaka, 2016, Seya et al., 2020) but have recently been extended to non-technical people (Seya et al., 2019). Seya et al.


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(2019), with the same course curriculum as this study, showed that a story-based, visual and agile teaching method for non-technical adult learners engendered learner success in understanding AI and it also made the learners more confident with programming tasks than when they started the course. However, Seya et al. (2019) did not discuss how to create story-based lectures. The novelty of this study lies in filling this gap and clarifying one of the effective methods for creating story-based lectures for non-technical adult learners who want to learn AI. This study also found that story-based lectures created by this method could resolve six common issues (Wang et al., 2018) that conversational programmers face.

The remainder of this paper is organized as follows. Section 2 summarizes the related works. Section 3 explains the proposed method for creating story-based lectures. Section 4 presents the evaluation method. Section 5 presents the results. Section 6 discusses the results. Section 7 concludes and makes suggestions for future research.

## 2. RELATED WORKS

Currently, various technical courses are delivered in the form of online classes, offline classes, or a combination of both, and there exist studies seeking effective educational methods for advanced and complex technology like AI in each delivery form (Seya et al., 2019, 2020; Seya and Shirasaka, 2016). The scope of study has been extended to cover not only technical people but also non-technical people, and not only students but also adult learners (Seya et al., 2019).

A study (Seya et al., 2020) on a fully automated online educational method for technical people to learn AI identified five issues and suggested the possibility of prediction in advance of whether the learners could finish the course alone without support by checking the level of knowledge of their programming skills and mathematics before the course starts. Although this study concerned technical learners, similar problems occur for non-technical learners.

A study (Seya and Shirasaka, 2016) on in-class teaching methods to provide specialized technical education for technical students explored effective teaching methods that can cope with dynamic changes in a learner's level and proposed a way to control the use of the open-close principle (Meyer, 1988) to separate concept learning and its implementation. Using this method, it is possible to flexibly respond to each learner's different level of implementation skill, but this is the same as the teaching method for the same learner to deepen the skills for the same task. The teaching method would be different for non-technical people who don't know anything about technology.

A study (Seya et al., 2019) on teaching methods for non-technical adult learners to learn AI basics in the form of blended learning showed the effectiveness of a story-based, visual and agile teaching method. This study targeted non-technical adult learners who need to ground themselves in technical conversations at work even though they do not write any code themselves. In order to make non-technical adult learners satisfied with the course, the course was designed to support them to easily understand challenging technical topics, to complete the course within a 24 – 48-hour timeframe, and to accommodate learners with a wide range of experiences and ages. However, the


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characteristics of such an effective method and how to create story-based lectures were not clarified in the study.

## 3. PROPOSED METHOD

In order to make complex technology like AI easy to understand, it is necessary to loosen the thread of complicated intertwined stories and linearize the stories. Moreover, if the elements that make up the story are connected to each other by some clear reason, it becomes easier for learners to find a reason to learn each element in relation to the others. So, we looked at history as a way of linearizing stories because history is essentially linear in the sense that things occur chronologically. Moreover, there are many cases in which two events are connected by a cause-and-effect relationship. This is good for learners as it means the reasons they need to understand the topics are naturally understood.

### 3.1. PROCEDURE TO CREATE A STORY-BASED LECTURE

As a method of constructing lectures based on historical stories, we propose the procedure shown in Table 1. Step 1 to Step 4 are abstract work to determine the major flow of the lecture, and Step 5 to Step 9 are implementation work to make concrete the lecture content.

It is difficult to predict what would happen in an actual lecture session with abstract work (i.e., Step 1 to Step 4) alone. Therefore, after the implementation work (i.e., Step 5 to Step 8), problematic parts will come to light. If such problems are found, iteration from Step 8 back to Step 2 is repeated. When all the lecture blocks on the chronological storyline are completed in Step 8, a new lecture block that explains the flow of the whole lecture is created, and that block is placed as the first lecture block for the course in Step 9.

Table 1: Procedure to Create a Story-based Lecture.

| Step | Description |
|---|---|
| Step 1 | Set a concrete learning goal. |
| Step 2 | Identify chronologically related main topics which are necessary for accomplishing the concrete learning goal. |
| Step 3 | Identify sub-topics which are necessary for accomplishing the goals of main topics. |
| Step 4 | Temporarily fix main topics and sub-topics as lecture blocks. |
| Step 5 | Implement main topics as chronologically ordered lecture blocks. Try to implement a sub-topic inside a closely related main lecture block unless the volume of the main lecture block becomes too large. |
| Step 6 | Implement lectures for large sub-topics as independent lecture blocks. |


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| | |
|---|---|
| Step 7 | Implement both core learning tasks for all learners and advanced learning tasks for advanced learners in each lecture block. Learning tasks should be broken down to small, related learning blocks to enable the agile method. |
| Step 8 | Fix the lecture blocks if they are not compatible with administrative constraints. Go back to Step 2 if it is necessary to meet the constraints. |
| Step 9 | Place an introduction of the subject as the first lecture block and explain the whole picture of the lecture in this block. Place an outline session at the beginning of each lecture block to explain the role of the lecture block in relation to the previous topic. |

The following explains the points to be noted in the work of each step with reference to Table 1 and Figure 1.

- Step 1: Set the learning goal to produce as concrete a deliverable as possible. Setting the goal concretely makes it easy to select the learning topics needed to achieve that goal. This will help with the work from Step 2 onwards.
- Step 2: Choose the main topics needed to achieve the learning goal. However, the topics selected here are topics with time-series dependency. Arrange the lecture blocks to teach these topics in historical order. This process will clarify the boundaries between the main topics and other topics.
- Step 3: Identify the sub-topics needed to teach the main topics. Here, it is not necessary to be aware of the chronological dependencies of these sub-topics. Since these are topics determined in Step 2 which have no time dependency on the main topics, they are likely to be topics that are related to multiple topics, such as mathematics.
- Step 4: Temporarily fix the selected main topics and sub-topics, assuming that they will be taught as lecture blocks.
- Step 5: Since sub-topics do not depend on time, there can be multiple places where they can be inserted. The appropriate time to learn a sub-topic is right before learners actually use that knowledge. However, if a large sub-topic is inserted into the chronological storyline, learners would spend too much time on learning the sub-topic. This would promote the elimination of previously learned stories from the learner's memory. In order to get into the chronological storyline while avoiding such a problem, sub-topics should be broken down to smaller pieces.
- Step 6: Large sub-topics are implemented as lecture blocks that are taught independently.
- Step 7: Each lecture block should implement two types of learning task: core learning tasks and advanced learning tasks. These learning tasks are prepared for all learners and for advanced learners respectively.
- Step 8: If there is no problem in managing a lecture block, fix the contents of the lecture block. If problems occur, such as when a particular lecture block takes too long, adjustments will be required. A problematic lecture block might need to be divided into two lecture blocks. In that case, return to Step 2.
- Step 9: Create a new lecture block that explains the flow of the whole lecture, and place that block as the first lecture block on the chronological storyline. In addition, at the beginning of each lecture block, prepare a session to explain the position of the lecture block in the whole lecture.


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## 3.2. LECTURE BLOCK

Each lecture block should have two types of flow: lecture flow and hands-on lab flow. Lecture sessions explain learning objectives and are placed on the lecture flow. Hands-on practice sessions are for the learners to do learning tasks using a computer and are placed on the hands-on lab flow. Each session should be implemented in a relatively short time (5 ~ 15 minutes). A hands-on practice session should follow right after the corresponding lecture session is completed. It is recommended to configure two adjacent sessions to have a causal relationship between them. Figure 2 shows the two types of flow and the sessions on each flow.

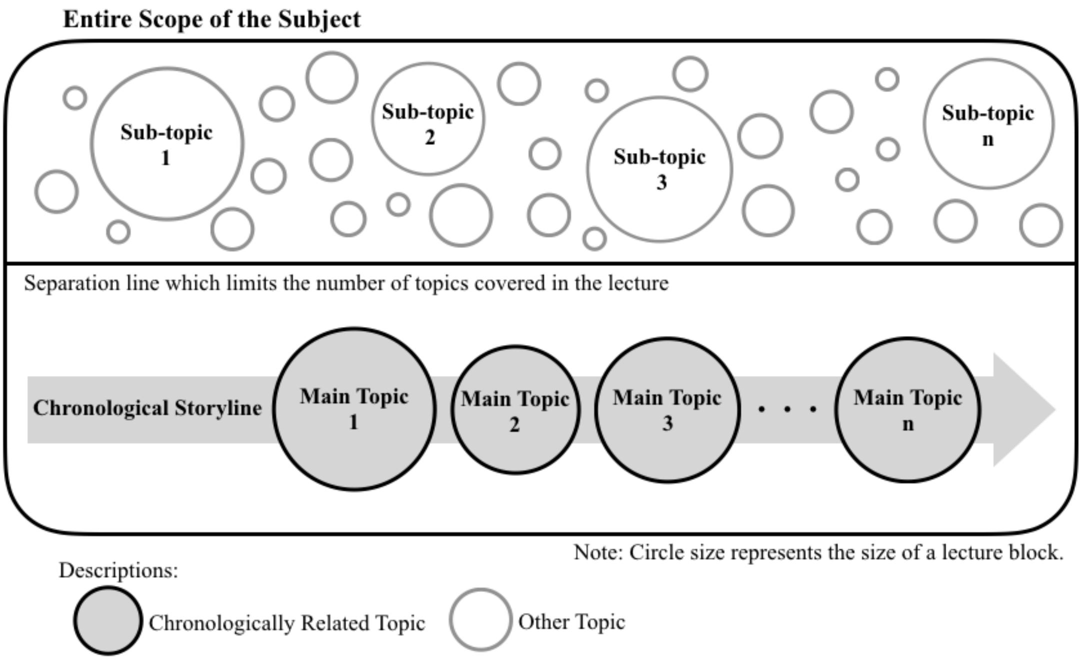


Figure 1. Configuration of Different Learning Topics.

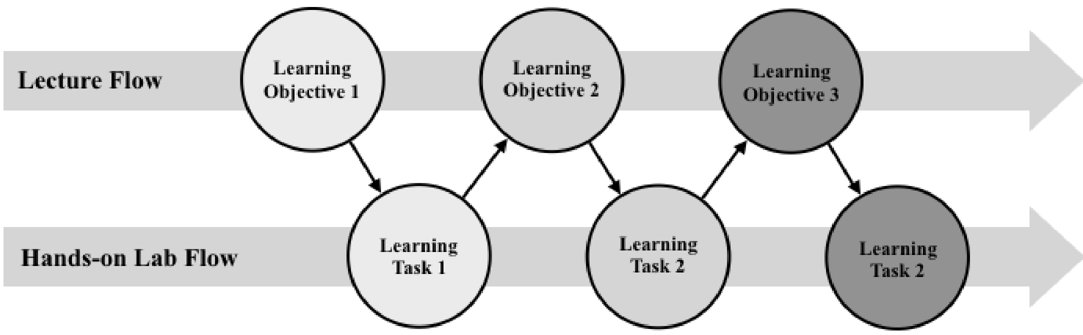


Figure 2. Learning Sessions in a Lecture Block.

## 3.3. DOUBLE SCOPE TASKS


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The age range of adult learners tends to be wide. As a result, the individual experiences and knowledge learners bring to the lecture differ greatly. The lecturer must be aware of this fact and think about how to deal with it.

The core learning scope should be set for each learning session and it should be mandatory for all learners to finish all the learning tasks defined in the core learning scope. It would be nice to check if the learners completed the tasks using an automatic scoring function. It may be difficult for beginners even to handle tasks within the core scope. However, due to differences in levels between learners in many respects, there may be many students who feel that the core learning tasks are not demanding enough. In order to handle such cases, prepare advanced tasks that can be tackled in the remaining time for the learners who finished core tasks, or prepare equivalent methods.

In this way, advanced learners can explore the areas beyond the core scope on their own while allowing other regular learners to work on the tasks within the core scope. Figure 3 shows the dual scope of a particular subject. The white circles in the figure represent the learning content covered during the lecture but they are not included as a part of the lecture.

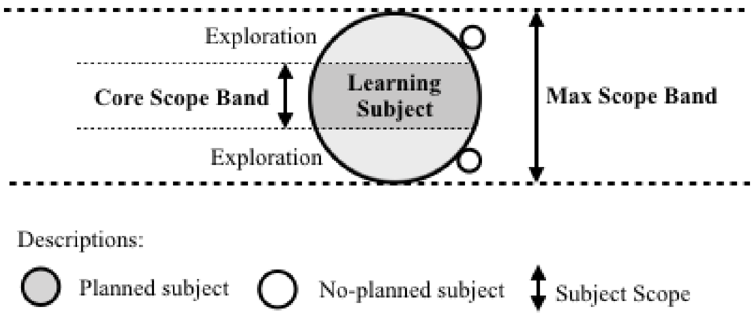


Figure 3. Double Scope Tasks.

## 4. EVALUATION METHOD

First, a story-based lecture for a basic AI course from the past-to-present perspective was created for non-technical adult learners by the proposed method in this paper. Then we implemented this course as a blended course and executed the lecture with the flow depicted in Figure 4. During the lecture, we collected test scores before and after each lecture block to evaluate the effectiveness of the lecture in terms of the magnitude of the change in the learners' knowledge about the topics.

Table 2 shows the list of question items which were asked to the participants via a questionnaire survey. For the question item Q1, 'Did you think the style of learning Artificial Intelligence while following its history is good?', responses were given on a seven-point ordinal scale, ranging from -3-'disagree,' to +3-agree,' with 0 representing 'neither agree nor disagree'. For the question item Q3, 'How likely are you to recommend this course to your friend?', responses were given on an 11-point rating scale, ranging from 0 (not at all likely) to 10 (extremely likely).


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Table 2. Question Items After the Lecture.

| Question ID | Question |
|---|---|
| Q1 | Do you think the style of learning Artificial Intelligence while following its history is good? |
| Q2 | Why do you think so? |
| Q3 | How likely are you to recommend this course to your friend? |
| Q4 | Why do you think so? |

In this study, we used the open-coding method (Kobayashi et al., 2018) to analyze free descriptive answers with the following procedure.

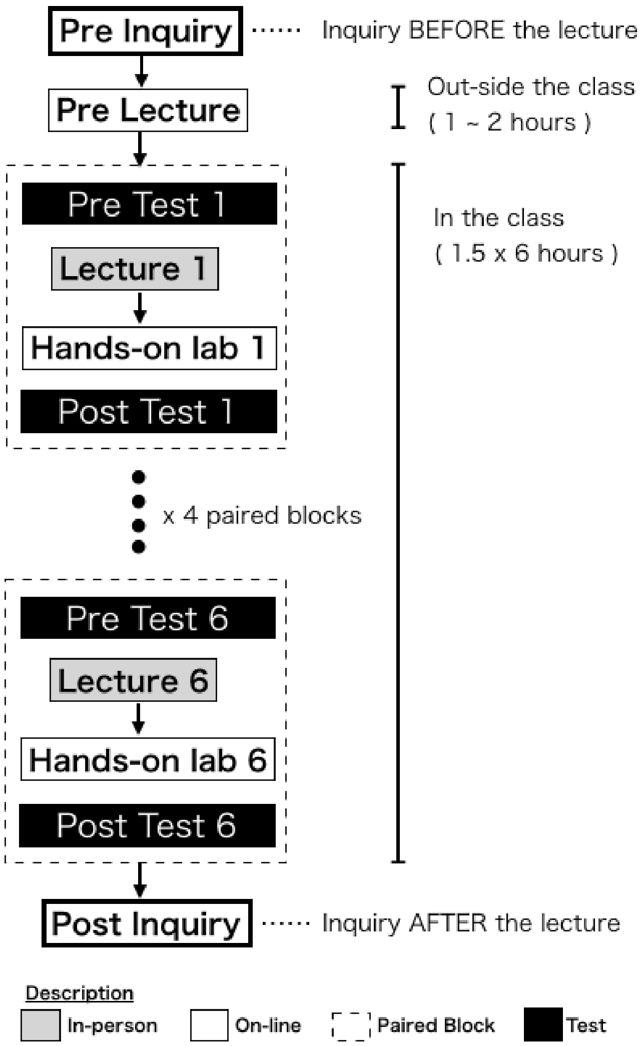


Figure 4: Flow of Blended Course.

- Step 1: View the free answers, and pick those related to history. The viewpoint set as "learning AI while following history" and "course satisfaction" for Affinity


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Diagram grouping, in order to clarify the effect of learning style and the satisfaction of the course.

- Step 2: Look for, from the aforementioned viewpoint, the descriptions related to structuralizing with multiple viewpoints, and sort them into groups.
- Step 3: Write titles for each group that summarizes the essence of the group, at a slightly higher level of abstraction (called "Open coding results" in this study).

In order to ensure the reliability of the open-coding result generated by the authors, we validated the result with an open-coding specialist (Golafshani, 2003).

## 5. RESULT

### 5.1. Participants' Profile

The participants in this lecture were business professionals from a wide range of industries and with different ages, job roles, and different levels of programming skill. In this study, we define a business professional as a person who has a job in a company. Table 3 summarizes the profiles of the participants.

Table 3. Participants' Profiles.

| **Age** | **Number of Participants** |
|---|---|
| 20 ~24 | 3 |
| 25 ~ 29 | 2 |
| 30 ~ 34 | 3 |
| 35 ~ 39 | 14 |
| 40 ~ 44 | 24 |
| 45 ~ 49 | 23 |
| 50 ~ 54 | 19 |
| 55 ~ 59 | 2 |

| **Programming expertise** | **Number of Participants** |
|---|---|
| No Experience | 58 |
| Entry level | 24 |
| Junior level | 6 |
| Senior level | 2 |

| **Job Role** | **Number of Participants** |
|---|---|
| Manager | 11 |
| Clerical Work ( Human Resources, General Affairs, Accounts, Communications ) | 14 |
| Sales | 12 |


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| | |
|---|---|
| Marketing | 7 |
| Strategic Marketing Planning | 11 |
| Strategic Engineering Planning | 10 |
| Engineer | 9 |
| Other | 16 |

From the 90 participants, we selected 75 target participants as non-technical adult learners by removing participants who played an engineering role in the office and who had a junior or senior level of programming expertise, because they were close to technical professionals in terms of their programming expertise although she or he served a non-technical role in the office. On the other hand, we removed all the participants who take an engineering role in the office even though they claimed to belong to 'No Experience' and 'Entry level' categories because they might underestimate themselves.

### 5.2. History-based Story Result

The following is the result of each step defined by the proposed method for creating story-based lectures.

- Step 1: Set a concrete learning goal. The target learners for this course are non-technical adult learners (members of society who have a job). Mostly, many years have passed since the learners graduated from school. It is assumed that the learners have never followed the program or are at beginner level. Typically, the learners are non-technical workers but, in their role, need to be able to participate in AI discussions. The learning goals are set to 'Be able to explain AI to others' and 'Be able to imagine the technology behind artificial intelligence'. In order to achieve these goals, a concrete final artifact requested in this course is 'A program that recognizes handwritten numbers with Deep Learning'.
- Step 2: Identify chronologically related main topics which are necessary for accomplishing the concrete learning goal. The learning goal expects the concrete artifact that uses Deep Learning to recognize handwritten numbers. Naturally, the chronological order of learning topics becomes 'Logistic Regression', 'Neural Network' and 'Deep Learning'.
- Step 3: Identify sub-topics which are necessary for accomplishing the goals of main topics. Since one of the learning goals is "Be able to imagine the technology behind artificial intelligence" and the expected artifact at the end of the course is 'A program that recognizes handwritten numbers with Deep Learning', the learners need to understand the basics of image, programming, and mathematics.
- Step 4: Temporarily fix main topics and sub-topics as lecture blocks. In this step, fix the following five learning topics extracted so far:
    (1) Deep Learning
    (2) Neural Network
    (3) Logistic Regression


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(4) Programming
(5) Mathematics
(6) Image

There is a historical relationship among the main topics (1), (2) and (3). The larger the number is, the older it is. There is no time dependency among the sub-topics (4), (5) and (6). Figure 5 shows the result at this point.

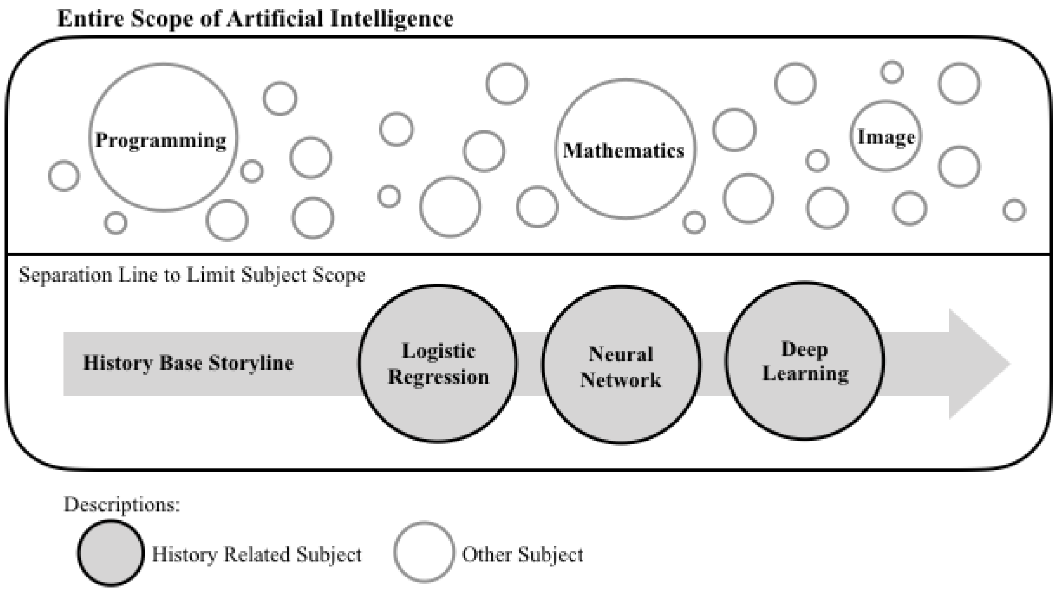


Figure 5. Initial Version of History-Based Storyline.

- Step 5: Implement lectures for main topics and arrange the lecture blocks chronologically. Try to implement a sub-topic inside a closely related main lecture block unless the volume of the main lecture block becomes too large. Since the sub-topic of "Image" does not take too much time to teach, we decided to teach this topic just before the learners need to work on handwritten images when they are learning about Deep Learning (Figure 6). "Programming" and "Mathematics" are too large to put onto the history base storyline. Although it could be possible to divide them into small pieces to insert them into the history base storyline, we did not take that option. Instead, we decided to teach them independently outside the history base storyline for the purpose of learning efficiency.

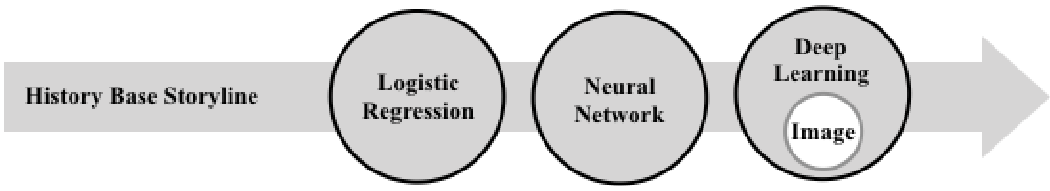


Figure 6. Image Topic is Covered in the Deep Learning Topic.

- Step 6: Implement lectures for large sub-topics as independent lecture blocks.
Try to implement a sub-topic inside a closely related main lecture block unless the volume of the main lecture block becomes too large. We decided to teach "Programming" and "Mathematics" online. We expected the learners to finish


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

them by themselves before the in-person lecture. In order to mitigate learning difficulty, we used the visual teaching method (Seya et al., 2019). Figure 7 shows the result at the end of Step 6.

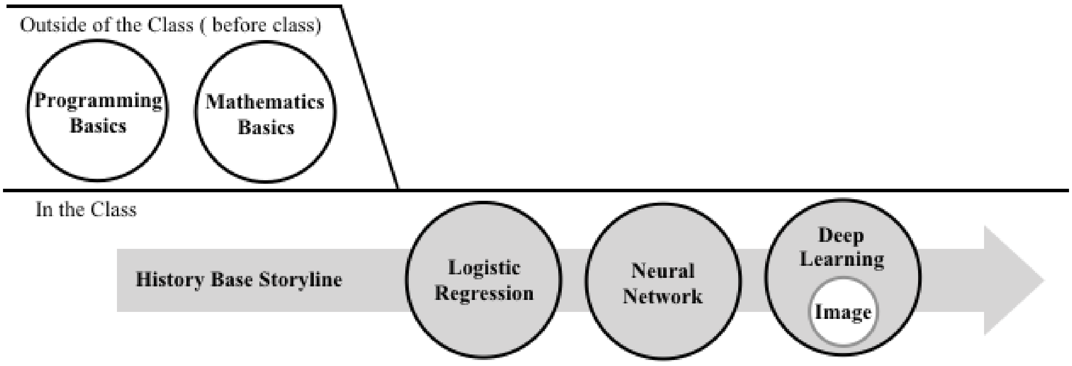


Figure 7: Preliminary Design of AI Course.

- Step 7: Implement both core learning tasks for all learners and advanced learning tasks for advanced learners in each lecture block. We implemented the core learning tasks which all learners must work on. For the advanced learners who could explore beyond the prepared exercises, instead of providing challenging exercises, we provided an environment where the learners could freely change their code and try it out after completing core learning tasks. In this way, the learners could play with their code by themselves at their own level (Figure 8). This environment was enabled by Jupyter Notebook, which is widely adopted by researchers, data analysts, and even journalists (Rule, Tabard and Hollan, 2018).

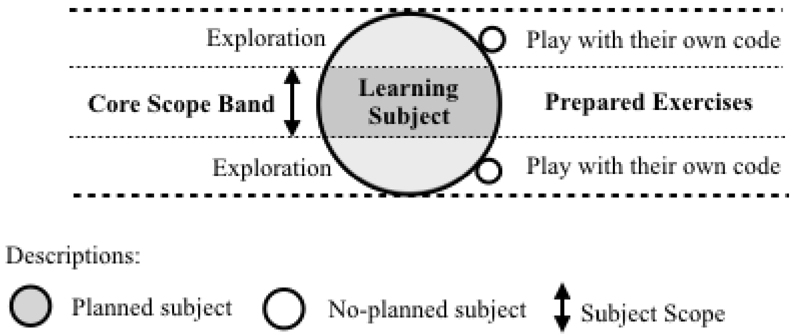


Figure 8. Core Learning Tasks and Exploration

In each lecture block, we provided the learning objectives as small, related sessions (Figure 9). These sessions were designed to be small to enable the agile teaching method (Seya et al., 2019).


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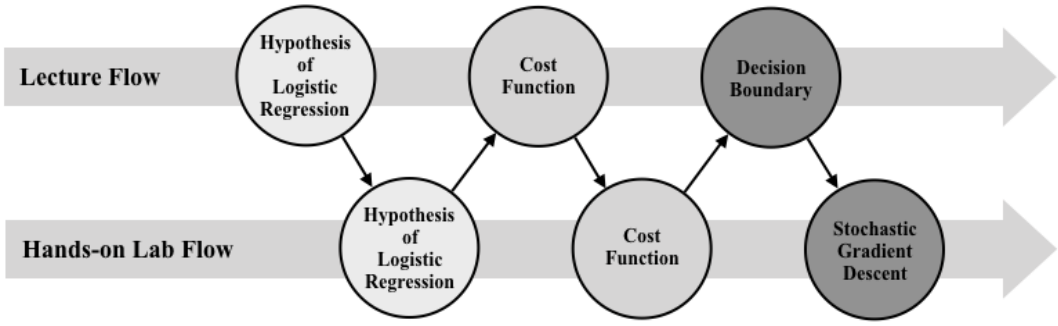


Figure 9. Lecture Sessions and Hands-on Sessions for Linear Regression.

- Step 8: Fix the lecture blocks if they are not compatible with administrative constraints. Go back to Step 2 if it is necessary to meet the constraints.
  Generally, it becomes easier to do more advanced tasks later in the course. However, when the learners have just moved into the session about the neural network from the session about logistic regression, they are only capable of solving a binary problem. In order to recognize handwritten numbers with deep learning, the learners need to know how to solve a multi-class problem because there are ten figures, 0 ~ 9, that need to be recognized and classified. In principle, it is possible to teach how to solve a multi-class problem in the neural network teaching block, but it is not a good idea to do so in practice because the teaching block becomes too large. Similarly, the teaching block for logistic regression turned out to be too large. In order to align with administrative constraints such as the length of the lecture defined by the educational institution, we decided to go back to Step 2 in order to reconfigure the teaching blocks.
- Step 2 (2nd Round): Identify chronologically related main topics which are necessary for accomplishing the concrete learning goal. We decided to have a teaching block for multi-class classification by taking this session out of the teaching block for the neural network. We placed the teaching block for multi-class classification between the teaching block for the neural network and the teaching block for deep learning. Similarly, we decided to have a teaching block for linear regression separated from the teaching block for logistic regression instead of teaching it as the input for logistic regression. Linear regression is a simple algorithm, but it contains fundamental concepts such as cost function and stochastic gradient descent. Therefore, the teaching block for linear regression also serves the role of establishing fundamentals for the rest of the teaching blocks. Figure 10 shows the result at the end of Step 6.

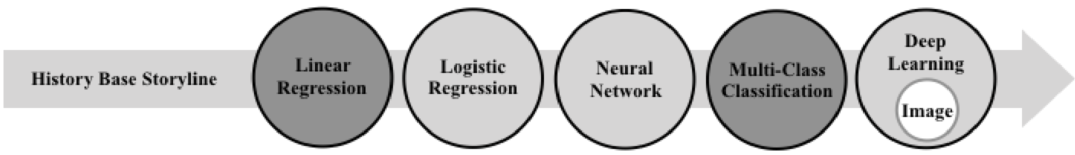


Figure 10. Two New Teaching Blocks Added to the History-based Storyline.

- Step 3 (2nd Round): No change
- Step 4 (2nd Round): Temporarily fix main topics and sub-topics as lecture blocks.


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In this step, fix the following seven learning topics extracted so far:

(1) Deep Learning
(2) Multi-Class Classification
(3) Neural Network
(4) Logistic Regression
(5) Linear Regression
(6) Programming
(7) Mathematics

- Step 5 (2nd Round): No change
- Step 6 (2nd Round): No change
- Step 7 (2nd Round): No change
- Step 8 (2nd Round): No change
- Step 9 (2nd Round): Place the introduction of the subject as the first lecture block and explain the whole picture of the lecture in this block. Also, place the outline session at the beginning of each teaching block to explain the role of the lecture block in relation to the previous topic.
  A session was added to the beginning of each lecture block to clarify the purpose and historical position of the lecture. Figure 11 shows the sessions in the lecture block for linear regression as an example. In this diagram, the session, "Linear Regression Overview" is added to the beginning of the teaching block.

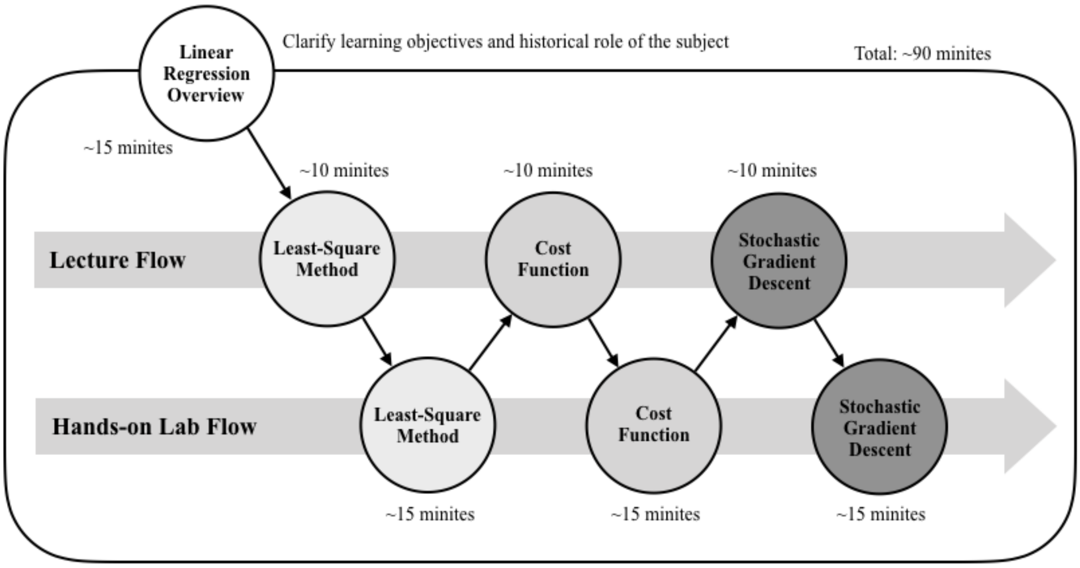


Figure 11. Sessions in the Teaching Block for Linear Regression.

In this step, we also placed the introduction of AI, "History of Artificial Intelligence", as the first lecture block to clearly explain the whole picture of the lecture in this block. The final result of the history-based lecture is depicted in Figure 12, with the real history of AI presented at the bottom. Table 4 summarizes the lecture flow, topics, and sessions covered in this lecture.


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

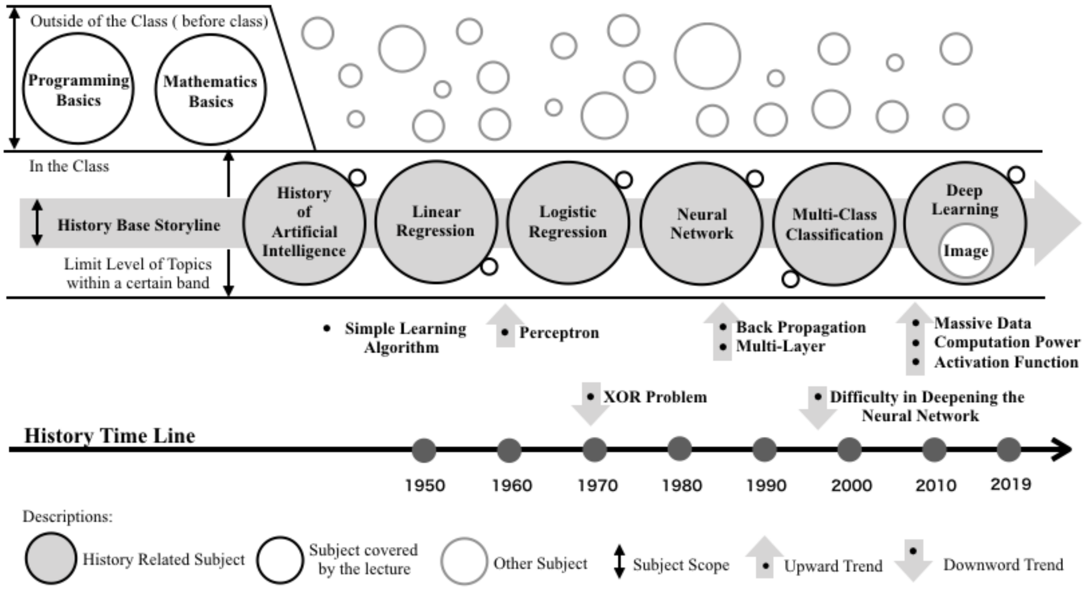


Figure 12. Teaching Blocks with the Real History of AI.

Table 4. Lecture Flow, Topics, and Sessions for AI Basic Course

| Lecture Flow | Topics Lecture Block | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 |
|---|---|---|---|---|---|---|
| Pre-Lecture | Programming Basics | Variable, Arithmetic, Array, For-loop, If-statement, Function | | | | |
| | Mathematics Basics | Vector, Matrix, Logarithm | | | | |
| Lecture 1 | History of Artificial Intelligence | History of Artificial Intelligence | Review of Programming | Review of Mathematics | | |
| Hands-on Lab 1 | | | Review of Programming | Review of Mathematics | | |
| Lecture 2 | Linear Regression | Linear Regression Overview | Least-Squares Method | Cost Function | Stochastic Gradient Descent | |
| Hands-on Lab 2 | | | Least-Squares Method | Cost Function | Stochastic Gradient Descent | |


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

| | | | | | | |
|---|---|---|---|---|---|---|
| Lecture 3 | Logistic Regression | Logistic Regression Overview | Hypothesis of Logistic Regression | Cost Function | Decision boundary | 2D Logistic Regression |
| Hands-on Lab 3 | | | Hypothesis of Logistic Regression | Cost Function | Decision boundary | 2D Logistic Regression |
| Lecture 4 | Neural Network | Neural Network Overview | Multi-Layer Perceptron | Back Propagation | Neural Network Model Initialization | |
| Hands-on Lab 4 | | | Multi-Layer Perceptron | Back Propagation | Neural Network Model Initialization | |
| Lecture 5 | Multi-Class Classification | Multi-Class Classification Overview | Multi-Class Classification | Three Classes Classification & Activation Function | Circle Data Classification | |
| Hands-on Lab 5 | | | Multi-Class Classification | Three Classes Classification & Activation Function | Circle Data Classification | |
| Lecture 6 | Deep Learning | Deep Learning Overview | Image Data Manipulation | Large Data Manipulation | | |
| Hands-on Lab 6 | | | Image Data Manipulation | Classification of Handwritten Digits | | |

### 5.3. History-based Lecture Favorability and Satisfaction

The responses to the question item Q1, ‘Did you think the style of learning Artificial Intelligence while following its history is good?’, are summarized in Table 5. The responses to the question item Q3, ‘How likely are you to recommend this course to your friend?’, are summarized in Table 6.


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 5. Did you think the style of learning Artificial Intelligence while following its history is good?

| Scale | Number of Votes |
|---|---|
| -3 (Disagree) | 0 |
| -2 (Disagree) | 0 |
| -1 (Disagree) | 0 |
| 0 (Neither agree nor disagree) | 2 |
| 1 (Agree) | 10 |
| 2 (Agree) | 20 |
| 3 (Agree) | 43 |

Table 6. How likely are you to recommend this course to your friend?

| Scale | Number of Votes |
|---|---|
| 0 | 0 |
| 1 | 0 |
| 2 | 0 |
| 3 | 1 |
| 4 | 1 |
| 5 | 2 |
| 6 | 1 |
| 7 | 16 |
| 8 | 17 |
| 9 | 13 |
| 10 | 24 |

## 5.4. Open Coding

The open coding results for the free format question item Q2, “Why is it?”, which describes the reason for the question item Q1, “Did you think the style of learning Artificial Intelligence while following its history is good?” are shown in Table 7.

Table 7. Open Coding Result for Question Item Q2.

| Open Coding ID | Open Coding Result | Number of Sentences |
|---|---|---|
| HIST_OC_01 | Knowledge is easily absorbed because it is accompanied by a story. | 9 |
| HIST_OC_02 | I think understanding will deepen if there is a background explanation. | 17 |
| HIST_OC_03 | It is easy to understand how it evolved in order. | 10 |
| HIST_OC_04 | It's easy to keep it in mind if the reason why the method is needed is understood. | 18 |
| HIST_OC_05 | By knowing the history, we can see the current issues and the future. | 20 |


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

| | | |
|---|---|---|
| HIST_OC_06 | It is easy to understand what AI is good at and not good at. | 5 |
| HIST_OC_07 | The whole structure (the formation of the current form) and the reason why various technologies (inventions) are used are easily understood. | 8 |
| HIST_OC_08 | My interest in AI increased as I understood why there was a boom (trends up and down). | 5 |
| HIST_OC_09 | It becomes easier to imagine the situation. | 14 |
| HIST_OC_10 | As I was able to know the history from the past, I could learn with a sense of reality. | 1 |
| HIST_OC_11 | Even though I am not good at mathematics, I am interested in history. | 3 |

The open coding results for the free format question item Q4, "Why is it?", which describes the reason for the question item Q3, "How likely are you to recommend this course to your friend?" are shown in Table 8.

Table 8. Open Coding Result for Question Item Q4.

| Open Coding ID | Open Coding Result | Number of Sentences |
|---|---|---|
| NPS_OC_01 | I feel the evolution in history and deepened my understanding with actual programming. I think it is a wonderful program that can be understood even by people who do not know the basics. | 5 |
| NPS_OC_02 | It would be useful to know what AI is and how it works in my work. | 11 |
| NPS_OC_03 | I think that it will be easier to imagine artificial intelligence and it can be used in future business. | 5 |
| NPS_OC_04 | I've read various books so far, but it was much easier to understand than them. | 25 |
| NPS_OC_05 | I am not very good at math and programming, but I enjoyed it and felt that I wanted to study more. | 32 |
| NPS_OC_06 | Because you can understand the theory behind it well and it will settle in your brain as you get your hands dirty. | 18 |
| NPS_OC_07 | By understanding the mechanics of AI, you can obtain the knowledge base you need to think about what you can do with AI. | 21 |


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

| | | |
|---|---|---|
| NPS_OC_08 | Easy to understand and interesting. You can really understand the essence. | 4 |
| NPS_OC_09 | Because you can learn the essence of machine learning in a short time. | 1 |

## 5.5. Test Scores

Participants took a pre-test before each teaching block started and took a post-test after each teaching block ended. The highest possible score was 800 points. The results of pre-test and post-test are shown in Table 9. The result of a paired T-test is shown in Table 10.

Table 9. Statistics of Post-test and Pre-test.

| | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Post-test | 589.18 | 67 | 101.618 | 12.415 |
| Pre-test | 188.43 | 67 | 98.505 | 12.034 |

Table 10. Paired T-Test.

| ID | Paired Differences | | | | | t value | Degree of freedom | P value (2-tailed) |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | Lower | Upper | | | |
| q01 | 400.7 | 121.2 | 14.80 | 371.2 | 430.3 | 27.08 | 66 | 0.000** |

** Significant at $p < 0.001$

Table 11 shows the Pearson correlation coefficient between the post-test score and Net Promoter Score. We also calculated the score gap between the post-test and pre-test and calculated the Pearson correlation coefficient between the score gap and Net Promoter Score, which is shown in Table 12. The reason why the degree of freedom is 65 while the number of target participants is 75 is due to missing data; 67 out of 75 participants were able to calculate entrance and exit tests correctly.


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

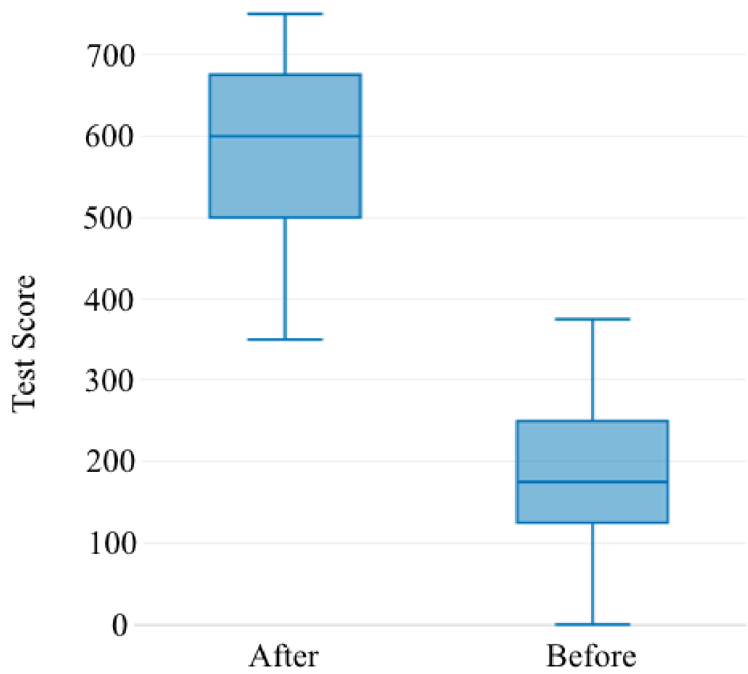


Figure 13. Box Plot of Pre-test and Post-test.

Table 11. Pearson Correlation Coefficient between Post-test and Net Promoter Scores.

| | Correlation Coefficient | t - Ratio | Degree of freedom | p-value (2-tailed) |
|---|---|---|---|---|
| Post-test Score and Net Promoter Score | 0.2724 | 2.282 | 65 | 0.0258* |

* Significant at $p < 0.05$

Table 12. Pearson Correlation Coefficient between Score Gap and Net Promoter Score.

| | Correlation Coefficient | t - Ratio | Degree of freedom | p-value (2-tailed) |
|---|---|---|---|---|
| Score Gap and Net Promoter Score | 0.2445 | 2.033 | 65 | 0.0461* |

* Significant at $p < 0.05$

## 6. EVALUATION METHOD

### 6.1. Story-based Lecture

We followed the proposed steps to build a story-based lecture for the basic AI course. Table 4 shows the results of all the tasks for building the lecture. In order to make the story linear, teaching blocks were provided in chronological order. The size of each teaching block (i.e., each topic) was about the same. This feature was naturally embedded in this proposed method because it forced us to make each teaching block small. This would increase the sense of linearity because the feature of linearity can be


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

maintained if the duration is short. Figure 14 shows a linearized storyline built with small, chronologically ordered teaching blocks. Sessions in a teaching block for linear regression are also shown in Figure 14 as an example of the structure inside each teaching block.

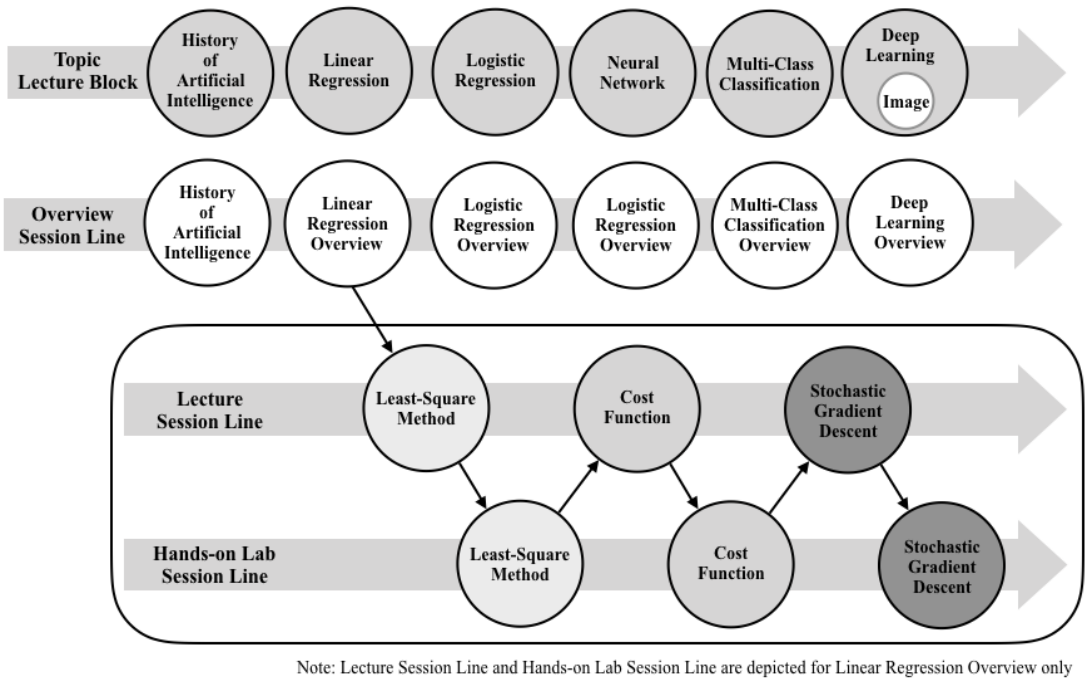


Figure 14. Linearized Storyline and Sessions in a Teaching Block

Teaching blocks for basic knowledge of programming and mathematics took about 1 to 2 hours as a task to be completed before a direct lecture given by a lecturer. By asking for the learning tasks to be completed online before the direct lecture, we obtained a secondary effect that all the participants were able to check their PC, which they used in class, before the direct lecture in person. Adult learners might not be used to handling a PC or their PC might be under strict security control by the company they work for, which could result in a network access problem. The lecturer needs to be aware of such administrative problems.

## 6.2. Learning Style Popularity and Satisfaction

All the responses to the question item Q1, ‘Did you think the style of learning Artificial Intelligence while following its history is good?’, were above 0; there were no negative responses. The average was 2.39, with the response range on a 7-point scale between -3 and +3. This result indicates that most of the participants liked this style. We categorized effective reasons with the evaluation points on why participants liked this style. Table 13 shows the results.

## 6.3. Satisfaction

The responses to the question item Q3, ‘How likely are you to recommend this course to your friend?’’, show that the number of promoters who marked 10 and 9 was 39, the number of passive people who marked 8 and 7 was 33, and the number of detractors


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who marked under 6 was 5. The Net Promoter Score was +45%. The Net Promoter Score is said to give more serious responses with a sense of responsibility by letting respondents think about the future behavior of recommending to close people, not just their own satisfaction. Therefore, it may be considered that she or he is making an objective judgment rather than a mere personal impression. The act of "recommending to people" cannot be done without trust and attachment to the lecture. Therefore, those who answered that she or he would actively recommend have a positive attitude towards the lecture. In other words, it suggests that there is a high possibility that it is linked with a positive intention that leads to the continuation of learning.

The reasons the participants were satisfied with the lecture were analyzed by the open coding method over the free format question item Q4, “Why do you think so?” and are summarized in Table 8. We categorized effective reasons with the evaluation points on why participants were satisfied with this course. Table 14 shows the results. The points, “understand” and “easy to understand’ are similar but we distinguished between them.

Table 13. Effective Reasons for Learning Style Popularity.

| Effective Reasons | Evaluation Points | Open Coding ID |
|---|---|---|
| Grasp the whole and check the positioning of the learning content. | flow, direction, and position | HIST_OC_05 |
| | whole picture | HIST_OC_07 |
| The story is linearized and easy to understand. | linearization | HIST_OC_03 |
| It is easy to understand because of the causal relationship. | causal relationship | HIST_OC_04 |
| Learning content becomes easy to understand with context given through a story. | story | HIST_OC_01 |
| | context | HIST_OC_02 |
| It becomes easy to imagine. | easy to imagine | HIST_OC_09 |
| It enables comparison. | comparison | HIST_OC_06 |
| It increases interest in the subject. | interest | HIST_OC_08 |
| | history | HIST_OC_11 |
| It gives a real feeling about learning topics. | reality | HIST_OC_10 |


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 14. Effective Reasons for Satisfaction.

| Effective Reasons | Evaluation Points | Open Coding ID |
|---|---|---|
| I can understand. | History helps in understanding | NPS_OC_01 |
| | understandable | NPS_OC_05 |
| I can imagine the subject. | imaginable | NPS_OC_03 |
| It is easy to understand. | easy to understand | NPS_OC_04 |
| It is practical. | practical | NPS_OC_02 |
| I can feel it. | reality | NPS_OC_06 |
| I can gain knowledge. | knowledge | NPS_OC_07 |
| It is fun to study. | fun | NPS_OC_08 |
| I can learn the subject in a short time | short time | NPS_OC_09 |

### 6.4. Possible Solution for Conversational Programmers

The open coding results in Table 7 imply the history-based story linearizes the story, providing causality and context because the results include HIST_OC_02, ”I think understanding will deepen if there is a background explanation.”, HIST_OC_03, ”It is easy to understand how it evolved in order”, and HIST_OC_04, “It's easy to keep it in mind if the reason why the method is needed is understood.” Moreover, history is a story by itself and it is persuasive because it is real. Therefore, the learners can learn the content with reality as one of the open coding results, HIST_OC_10, “As I was able to know the history from the past and I could learn with a sense of reality.” Also, in order to save time for learning it is possible to limit the number of topics taught by restricting the topics to historically important subjects. In this way, the learners can learn the content without falling into too many details. For these reasons the following effects could be expected:

(1) Learners can imagine the content being discussed including the context
(2) Linearize the story (intelligible)
(3) It becomes easy to connect the topics before and after in a causal relationship
(4) It is persuasive, and learners can also check the credibility of the content by themselves
(5) Real and substantial value
(6) Easy to understand, focus on the most important outlines and save on learning time
(7) The market value increases if you gain the sense and knowledge that you can use it at work

These benefits can be used to eliminate six problems (Wang et al., 2018) where non-technical adult learners, called conversational programmers, have feelings of failure when learning about technical topics (Table 15).


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 15. Six Common Reasons for Feelings of Failure Among Conversational Programmers When Using Modern Resources (Wang et al., 2018).

| Issue ID | Reasons for Feelings of Failure | Description |
|---|---|---|
| i01 | Takes too much time | Investing in learning programming ended up requiring more time than participants wanted to devote given their busy schedules. |
| i02 | Too much focus on syntax and logic | Most of the resources focused on programming syntax and logic which did not directly help participants with their technical conversations. |
| i03 | Explanations are not relevant | The conceptual and application-related explanations desired by the participants were not always relevant nor available in the learning resources. |
| i04 | Difficult to assess the content's reliability | Participants did not feel confident enough to assess whether a given resource contained accurate and reliable content. |
| i05 | Feelings of social isolation | Resources and learning environments that target CS students or professional programmers often created feelings of social isolation among participants. |
| i06 | Easy to forget details | It was easy for participants to forget programming definitions and details because they did not apply what they learned directly on-the-job. |

Table 16 shows how each open coding result relates to solving the six problems conversational programmers face. The mark, 'O', in Table 16 indicates a possible relationship between an open coding result and the issues.

Table 16. Why the Approach Solves Six Problems Conversational Programmers Face.

| Open Coding ID | Open Coding Result | Issue ID | | | | | |
|---|---|---|---|---|---|---|---|
| | | i01 | i02 | i03 | i04 | i05 | i06 |
| HIST_OC_01 | Knowledge is easily absorbed because it is accompanied by a story. | O | | O | | O | O |
| HIST_OC_02 | I think understanding will deepen if there is a background explanation. | | | O | O | | O |
| HIST_OC_03 | It is easy to understand how it evolved in order. | O | | O | | O | O |


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HIST_OC_04 | It's easy to keep it in mind if the reason why the method is needed is understood. | | | O | O | | O |
| HIST_OC_05 | By knowing the history, we can see the current issues and the future. | | | O | | | |
| HIST_OC_06 | It is easy to understand what AI is good at and not good at. | | | O | | | |
| HIST_OC_07 | The whole structure (the formation of the current form) and the reason why various technologies (inventions) are used are easily understood. | | | O | | | |
| HIST_OC_08 | My interest in AI increased as I understood why there was a boom (trends up and down). | | | O | | | |
| HIST_OC_09 | It becomes easier to imagine the situation. | O | O | O | | | O |
| HIST_OC_10 | As I was able to know the history from the past and I could learn with a sense of reality. | | | O | | | O |
| HIST_OC_11 | Even though I am not good at mathematics, I am interested in history. | | | O | | O | |
| NPS_OC_01 | I feel the evolution in history and deepen my understanding with actual programming. I think it is a wonderful program that can be understood even by people who do not know the basics. | | | O | O | O | O |
| NPS_OC_02 | It would be useful to know what AI is and how it works in my work. | | | O | | | |
| NPS_OC_03 | I think that it will be easier to image artificial intelligence and it can be used in future business. | | | O | | | |
| NPS_OC_04 | I've read various books so far, but it was much easier to understand than them. | O | O | | | O | |


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NPS_OC_05 | I am not very good at math and programming, but I enjoyed it and felt that I wanted to study more. | | O | | | O | O |
| NPS_OC_06 | Because you can understand the theory behind it well and it will settle in your brain as you get your hands dirty. | | | | O | | O |
| NPS_OC_07 | By understanding the mechanics of AI, you can obtain the knowledge base you need to think about what you can do with AI. | | | O | | | |
| NPS_OC_08 | Easy to understand and interesting. You can really understand the essence. | O | O | | O | O | O |
| NPS_OC_09 | Because you can learn the essence of machine learning in a short time. | O | | | | O | O |

The reasons why each problem can be solved are as follows:

i01: Takes too much time

(HIST_OC_01) If the story helps and knowledge is easier to keep in mind, less time is spent working

(HIST_OC_03) By linearizing and reducing complexity, there is no return and time can be shortened.

(NPS_OC_07) If learners can get the whole picture, they can focus on just the parts they need and therefore they can reduce learning time.

(NPS_OC_04) If it is easy to understand, it takes less time to understand.

(NPS_OC_05) If learners are willing to learn by themselves, the sense of taking too much time will diminish.

(NPS_OC_08) If it is fun, the feeling that it takes too long will weaken.

(NPS_OC_09) The lecture itself takes a short time.

i02: Too much focus on syntax and logic

(HIST_OC_09) Reduce learning time by focusing on understanding images rather than remembering details.

(NPS_OC_04) If it is easy to understand, even complex content will not feel troublesome.

(NPS_OC_05) If learners are willing to learn by themselves, it will be easier for them to work on complex content.

(NPS_OC_08) If it is fun, it will be easier to work on complex content.

i03: Explanations are not relevant

(NPS_OC_01 ~ HIST_OC_11)

(NPS_OC_02) History inevitably becomes deeply related to the subject topic.


ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

(NPS_OC_03) Learners feel that they can actually put it to work by becoming able to imagine the topic.
(NPS_OC_07) Learners feel that they could actually accumulate useful knowledge.

i04: Difficult to assess the content's reliability
(HIST_OC_02) If the understanding is deepened, learners can confirm the authenticity of the content by themselves.
(HIST_OC_04) If learners understand the reason why the method is needed, they can evaluate the value of the metod by themselves.
(NPS_OC_01) If learners can absorb the content, learners can evaluate its reliability by themselves.
(NPS_OC_06) Learners can check the accuracy and credibility of the learning content by themselves.
(NPS_OC_08) If learners have an essential understanding, they can confirm the authenticity of the content by themselves.

i05: Feelings of social isolation
(HIST_OC_01) If it is easy to acquire knowledge in context, learners won't feel alienation due to the difficulty of the content.
(HIST_OC_11) History is not a technical detail, so everyone is equally welcome to join discussions.
(NPS_OC_01) If the content is selected for beginners, learners feel less alienation due to the difficulty of the content.
(NPS_OC_04) If it is easy to understand, learners won't feel a sense of alienation due to the difficulty of the content.
(NPS_OC_05) If learners feel positive about learning, they will be actively involved in the community.
(NPS_OC_08) If learners find learning interesting, their participation in the community becomes positive.
(NPS_OC_09) The shorter the learning time, the less the mental burden of community participation.

i06: Easy to forget details
(HIST_OC_01) It is difficult to forget if learners learn the context together.
(HIST_OC_02) It will be difficult to forget if the understanding is deepened.
(HIST_OC_03) Straight and simple stories are easier to remember than complex content.
(HIST_OC_04) It becomes difficult to forget if the reason for the need is understood.
(HIST_OC_09) Image-centric approach eliminates the need to remember details.
(HIST_OC_10) It is difficult to forget content that feels real.
(NPS_OC_01) Focusing on the basic content for beginners, learners won't have to remember complex details.
(NPS_OC_05) If learners feel positive about the content of learning, their mental burden of remembering will also decrease.
(NPS_OC_06) It is difficult to forget what is learned by actually doing.
(NPS_OC_08) If learners find the content interesting, it will reduce the mental burden of remembering.
(NPS_OC_09) If the learning time is short, there is no need to remember the details for a long time, so the burden on memory is reduced.


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From the reasons above, we assume it would be possible to solve or reduce the cause of feelings of failure for non-technical adult learners known as conversational programmers. However, due to the limitation of this study, these reasons do not necessarily apply to all conventional programmers.

### 6.5. Learning Performance Outcomes

The difference between pre-test and post-test scores was 400.75 points on average, indicating that the knowledge had grown to about +50% of the full score (i.e., 800 points) after the lecture. However, the correlation coefficient between the post-test score and satisfaction was only 0.2724. The correlation coefficient between satisfaction and the growth of the test score (i.e., the difference between pre-test and post-test scores) also showed a weak correlation at 0.2445. This indicates that not only the test results but also other factors may be related to satisfaction. This result is consistent with other studies (Sockalingam, 2013, Wu, Hsieh and Lu, 2015) that find the degree of satisfaction is not always directly related to the test result.

## 7. CONCLUSION

The novelty of this study lies in clarifying one of the effective methods of making a story-based lecture and its effectiveness for non-technical adult learners, which were not clarified by Seya et al. (Seya et al., 2020). In this paper, we proposed a method of creating story-based lectures from a past-to-present perspective and showed the effectiveness of the method over non-technical adult learners in terms of improvements in test scores and post-lecture satisfaction. We also analyzed the reasons why the history-based lectures were effective for non-technical adult learners by open coding analysis and showed how this method could be a possible solution for the six common problems conversational programmers face when using modern resources (Wang et al., 2018).

This study does not consider factors such as age, gender, or nationality. It is necessary to be careful with Net Promoter Score because the result might differ depending on the nationality of the participants. While this study explored one of the effective methods to create a story-based lecture for non-technical adult learners, there are other effective ways that should be explored further. The effectiveness of this method has not been tested other than with non-technical adult learners. A future research topic should identify the advantages of different story creation methods for the better use of each method. In order to approach this research topic, we should compare the story creation method for non-technical adult learners with the story creation method for highly specialized learners. In addition, we consider the contribution to online education for non-technical adult learners because it is one of the scalable solutions. The use of the proposed story creation method in the online courses will reveal the issues when it is used online.

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ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

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