Analyzing effectiveness of workshops for learning agile development principles

Shota Suzuki*, Ryushi Shiohama*, Masashi Kadoya*, Kazunori Sakamoto**,
Hironori Washizaki* **, Yoshiaki Fukazawa*
*Dept. Computer Science and Engineering
Waseda University
Tokyo, Japan
shota-01@akane.waseda.jp, washizaki@waseda.jp
**GRACE Center, National Institute of Informatics
Tokyo, Japan

***Abstract*—**

Workshops are sometimes known as effective ways to learn the human and social factors of software engineering. However, their effectiveness in learning agile development principles in particular has not yet been determined, despite the fact that numerous agile development workshops have been held over the years. In this paper, we analyze the effectiveness of agile development workshops through an experiment, and show that one of representative workshops is indeed effective at learning agile principles. Self-study is another commonly used method to learn something new. Therefore, we compare the effectiveness of workshops with that of self-study to better illustrate the effectiveness of agile development workshops. In our experiment, we examine 7 workshop subjects and 8 self-study subjects, and compare their scores on the agile mind check, which is a method used to measure their degree of mastery of agile principles. As a result, we demonstrate the effectiveness of agile development workshops, especially those that simulate actual experiences. We also show that one of workshops is more effective than self-study regarding the agile mind check score.

Keywords-component: Agile development workshops, workshop effectiveness

I. INTRODUCTION

With the emergence of information society in recent years, the scale and complexity of software have increased, and changes in demand due to advances in technology development happen frequently. In the waterfall model, it is difficult to respond quickly to change requests, and budget overrun and delivery delay problems are known to occur. [3][4][5]. In order to avoid these problems, an agile process is often used as the development process. However, the prevalence of agile development is still low, and lack of knowledge may be one of the causes. Workshops are effective at learning the human and social factors of software engineering [1], but their effectiveness has not yet been determined. There might be a possibility that self-study is more effective than workshops.

There are many workshops for learning agile development principles (hereafter "agile principles"), usually introduced on the Internet websites such as [22][23]. Due to high number and variety of available workshops, it is quite hard to confirm whether all of those available workshops are effective or not; it is preferable to grasp the trend of workshops and find out some representative ones. Moreover, workshop participants' understanding of agile principles should be quantified so that we could confirm the learning effectiveness precisely; however to the best of our knowledge, there is no research on how to measure such learning effectiveness targeting agile development workshops.

According to the above-mentioned background and problems, we specify the following research questions (RQs).

- RQ1. What kinds of agile development workshops are there, especially on the Internet?
- RQ2. How should a person's understanding of agile principles be quantified?
- RQ3. Is it possible to learn agile principles through selected representative workshops?
- RQ4. Is it more effective to learn agile principles through selected representative workshops than through self-study?

To address these research questions, we first survey the trend of agile development workshops by utilizing the Systematic Mapping technique. We then choose two representative workshops that simulate actual experiences to use in our workshop analysis experiment, and analyze the degree to which a person can learn agile principles, especially the agile frame of mind (i.e. "agile mind"), through those workshops. The results are compared with those of through self-study, and the effectiveness of agile development workshops is determined. The main contributions of this paper include:

- We reveal the recent trend of workshops for learning agile principles available on the Internet by the survey based on Systematic Mapping.
- We propose the agile mind check as a method to measure the degree of mastery of agile principles.
- We demonstrate that one of representative workshops is effective for learning agile principles regarding the agile mind check score.
- We demonstrate that attending one of representative workshops is more effective than self-study for learning agile principles regarding the agile mind check score.

Reminder of this paper is organized as follows: In chapter II, we describe background and summarize

Systematic Mapping which shows the trend of workshops for learning agile principles. In chapter III, we explain the experiment to analyze the effectiveness of workshops for learning agile principles. In chapter IV, we show the result of experiment. In chapter V, we describe related works, and in chapter VI, we summarize this paper and suggest future works.

II. SYSTEMATIC MAPPING OF AGEIL DEVELOPMENT WORKSHOPS

A. Systematic Mapping

A workshop is a brief intensive course, a seminar, or a series of meetings emphasizing interactions and exchange of information among its participants [8]. Workshops on agile development principles are held frequently.

We first analyze what kinds of agile development workshops are popular using Systematic Mapping to decide which types of workshop to investigate in our study; there are many different types of workshops, and we simply cannot investigate all of them. Systematic Mapping is "a defined method to build a classification scheme and structure a software engineering field of interest."[20] We applied this method with a screening step to analyze workshops according to the following steps:

- (i) Definition of Research Question
- (ii) Review Scope
- (iii) Conduct Search
- (iv) Screening Workshops
- (v) Key wording using Abstracts
- (vi) Data Extraction and Mapping Process

(i) Definition of Research Question

The first step in Systematic Mapping is to define research questions. This is used for screening and analyzing web sites that include information on workshops related to agile principles, which we found on Google using certain keywords. We set two research questions in relation to RQ1.

RQ1-1. Does the web site include information on workshops related to agile principles?

RQ1-2. To what kind of implementations of agile development and principles does the web site contribute?

(ii) Review Scope

In the second step of Systematic Mapping, we define the search scope of web sites in four steps. Firstly, we use the top thirty web sites displayed on the Google search engine. Secondly, we use different series of workshops that are held regularly. Then, we only use web sites that are directly relevant to workshops that contribute to the learning of agile principles. And finally, if two or more web sites include the same workshops, we only use one of them.

(iii) Conduct Search

Thirdly, we define the search engine and search keywords. In this Systematic Mapping, we use the Google search engine because it is one of the most commonly used search engines worldwide. We search for workshops with the keywords "Agile workshop" OR "Agile study group."

(iv) Screening Workshops

Next, we define the screening of web sites according to the workshops they are about. We only include workshops which contribute to the learning of agile principles, and which describe each behavior of agile development, because the purpose of this study is to analyze the effectiveness of workshops in learning agile principles. We exclude workshops that introduce other workshops on agile development. We also exclude workshops that develop some concrete software systems with agile development as introductory courses.

(v) Keywording using Abstracts

We then classify the web sites that passed the screening into three groups: year facet, method facet, and behavior (practices and tools) facet. These three facets are shown in Figure 1.

(vi) Data Extraction and Mapping Process

We summarize the results of the above steps in Table I, and show the obtained structure of Systematic Mapping in Figure 1 to show the trend of workshops. Most notably, in recent years, the number of workshops on management and customer has increased significantly. We can also see that the ratio of the number of workshops on agile methods to that of workshops on agile behavior remains low.

Based on these results, we choose Management and Team workshops as being the representative workshops for learning agile principles, and analyze their effectiveness in the ensuing experiment.

TABLE I. NUMBER OF SEARCH HITS BY YEAR FACET AND AGILE BEHAVIOR OR AGILE METHOD FACET

Year	Agile behavior	Agile method
2012	46	10
2011	28	9
2010	20	8
2009	14	4
~2008	4	3
Total	112	34

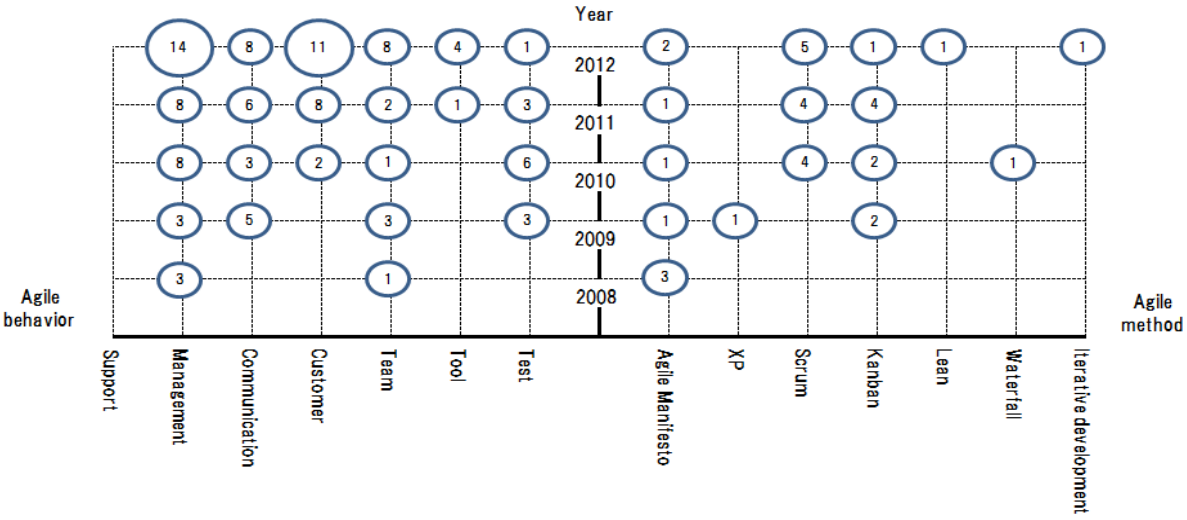

Figure 1. The Result of Systematic Mapping

B. *Issues regarding agile development workshops*

As we mentioned in Chapter II, there are many different kinds of agile development workshops. We can also verify this by looking at the result of Systematic Mapping in Figure 2. But, when we study something, we usually study it alone by reading books or documents, or by browsing the Internet; we typically do not attend workshops to study. Why then are workshops conducted for learning agile principles? To examine this, we first summarize features of self-study and studying through workshops in Table II.

According to Table II, we study more freely alone than in workshops in terms of time. If the effectiveness of workshops is not very different from self-study, attending workshops is not a necessary part of the learning process. However, workshops are held year after year, and their popularity appears to be increasing. Therefore, workshops are expected to be more effective than self-study, but this has not yet been demonstrated. The possibility exists that self-study is actually more effective than workshops.

III. ANALYSIS EXPERIMENT

A. *Proposed Analysis Scheme*

In this paper, we set four research questions to evaluate the effectiveness of agile development workshops. Among them, RQ1 was addressed in the previous chapter. Here, we address the concern that workshops may not be effective in learning agile principles, and analyze the effectiveness of agile development workshops.

B. *Flow of experiment*

We compare the case of attending workshops to that of self-study to analyze the effectiveness of agile development workshops. The subjects are assumed to be computer science majors and/or have programming experience. 15 graduate and undergraduate students studying software engineering in Reliable Software Engineering Laboratory of Waseda University are examined as subjects. According to their availability, these subjects have been split into three groups: five for the 1st workshop, two for the 2nd workshop, and eight for the self-study.

We show the flow of the experiment in Figure 2.

(i) Agile lessons

This experiment is targeted to beginners who have an interest in agile development, and people who need to learn how to use agile development for work. We first provide a 10-minute lesson on the principles of agile development for all subjects.

(ii) Preliminary agile mind check

After the 10-minute lesson, we measure the degree of mastery of agile principles of all the subjects using our questionnaire-based measurement method, named "agile mind check," which consists of 30 questions on the values and principles of the Agile Manifesto. All subjects are asked to answer the questions within 10 minutes.

(iii) Learning agile development

The group consisting of five subjects and another group consisting of two subjects learn more about agile principles through workshops, while the group consisting of eight subjects learns through self-study. In order to make a fair comparison, the study time for each group is set to 30 minutes.

(iiia) Workshops

The workshops used in this experiment are published on the Internet and are in the format of games. We employ two workshops on different dates moderated by one of authors, as follows.

The first workshop

The 1st workshop is titled "You Are Not in Control", introduced on the website [22]. In teams, have participants create as many paper airplanes as possible. In the experiment, three subjects were requested to create airplanes without having any roles or responsibilities; it leaded to form a self-organizing team. On the other hand, other two subjects were requested to have fixed roles (designer and implementer) while creating airplanes. Through this workshop, we can understand the agile team. Figure 3 shows a picture of the workshop in progress.

The second workshop

The 2nd workshop is titled "Making paper hats", introduced on the website [23]. The customer in this workshop tries to push the development team to build as many paper hats as possible during iteration. In this game the concepts of velocity and iteration/sprint are explained. The result is that most of the build paper hats are useless as the quality is quite low. Figure 4 shows a picture of the workshop in progress.

(iiib) Self-study

For self-study, we use documents publicly available on the Internet. We used [24][25][26][27] on self-study. Eight subjects conducted the self-study independently at different locations, such as homes and laboratories. We requested all subjects spend just 30 minutes; however there is a possibility that each spending time was not exactly 30 minutes. That is one threat to internal validity of the experiment.

(iv) Final agile mind check

Similar to the preliminary agile mind check, subjects answer questions on the values and principles of the Agile Manifesto after attending a workshop or conducting self-study, and we examine the degree of learning of the subjects. The questions are different from those of the preliminary agile mind check.

C. Classification in the field of agile development

Workshops on agile development have their own domains of contribution. For example, a workshop can contribute to the learning of the agile team, but not of the agile customer. Therefore, we analyze the effectiveness of workshops within their individual domains. For the domains, we use the classification of the principles of the Agile Manifesto (from (1) to (5)) as shown in [7], which is as follows.

TABLE II. FEATURES OF SELF-STUDY AND WORKSHOPS

	Self-study	Workshops
Time	Variable	Non-variable
Number of participants	1	10s
Expenses	Books	Registration fee
Subject expert	Unnecessary	Necessary
Advantage	Self-paced	Synergy among participants
Disadvantage	Can cause complacency	Depend more on the workshop design

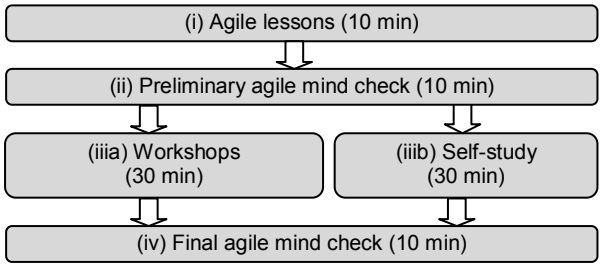

Figure 2. The Flow of the Analysis Experiment

(1) Role of team:

Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation. Agile development promotes sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely. The best architectures, requirements, and designs emerge from self-organizing teams. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly [7].

The 1st workshop is classified into this domain.

(2) Personal attitude:

Continuous attention to technical and good design enhances agility. Simplicity--the art of maximizing the amount of work not done--is essential [7].

(3) Software working:

Our highest priority is to satisfy the customer through early and continuous delivery of valuable software. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale. Working software is the primary measure of progress [7].

The 2nd workshop is classified into this domain.

(4) Collaboration with customers:

Business people and developers must work together daily throughout the project [7].

(5) Responding to changes:

Welcome changing requirements, even late in development. Agile development harnesses change for the customer's competitive advantage [7].

Figure 3. A picture of a workshop in the first workshop

Figure 4. A picture of a workshop in the second workshop

D. Agile mind check

As previously mentioned, we use agile mind check to analyze the subjects' degree of mastery. We prepared two versions of the agile mind check: the preliminary agile mind check and the final one. And each version consists of thirty questions divided into two parts.

In the first part, the subjects are given a list of agile principles along with twenty statements. The subjects must match each statement with the appropriate agile principle or indicate that the statement does not follow the agile mindset. For example, the statement, "The development team wrote a user story together with the customer," describes a situation based on the principle, "Business people and developers must work together daily throughout the project." Therefore, the subjects must match this principle with the statement to answer the question correctly. This question belongs in the domain of "collaboration with customers" based on the classification in the previous section.

The second part contains ten multiple-choice questions with four possible answers. A sample question is, "Who determines the value of the work?" The possible answers are "Customer," "Project leader," "Facilitator," and "All of the above." The correct answer is "Customer," so the subjects must choose "Customer" to answer the question correctly. This question also belongs in the domain of "collaboration with customers" based on the classification in the previous section. Agile mind check has been published on [30]. Many of questions in the second part are taken from samples of existing examinations [28][29] with slight modifications for making them comprehensive to students.

By preparing the agile mind check, we addressed RQ2.

IV. Analysis Results

A. Results of experiment

In this analysis, we perform a t-test of the mean to demonstrate that the results are statistically correct. When two groups of samples to be tested are the same, the paired two-sample t-test is carried out. When performing a test of the mean value of two samples with different groups, it must first be determined whether the samples have equal variances in order to use the correct assumption for the two-sample test.

In this experiment, there are a total of 15 subjects (workshops: 7, self-study: 8), and we set the rejection rate of the test of the mean at 10 percent.

From here on, subjects who participated in the first workshop will be referred to as first-workshop subjects and the percentages of correct answers associated with them are only of questions regarding the role of team. Similarly, subjects who participated in the second workshop will be referred to as second-workshop subjects and the percentages of correct answers associated with them are only of questions regarding software working. Subjects who participated in self-study will be referred to as self-study subjects.

RQ3. Is it possible to learn agile principlest through selected representative workshops?

To answer this question, we compare the percentages of correct answers before and after the workshops. First, we look at the data for the first-workshop subjects (1), and then perform a t-test comparing the mean percentages before and after the first workshop (2). We also examine the change in the percentage of correct answers of second-workshop subjects (3).

(1) Change in the percentage of correct answers of first-workshop subjects

We show the percentages of correct answers of first-workshop subjects on questions regarding the role of team in Table III. The average percentage of correct answers before the workshop is 42.5%, and it improves by 37.5 points to 80.0% after the workshop. We show the change in the percentage of correct answers in a box plot in Figure 5.

(2) T-test comparing the mean percentages before and after the first workshop

The alternative hypothesis and null hypothesis of the t-test comparing the mean percentages before and after the first workshop are given next. Alternative hypothesis is that there are differences in the average before and after the workshop. Null hypothesis is that there are no differences in the average before and after the workshop. We show the results of the t-test in Table IV. The rejection region is smaller than 10%. Therefore, the null hypothesis is aborted, and the alternative hypothesis is realized.

(3) Change in the percentage of correct answers of second-workshop subjects

We show the percentage of correct answers of second-workshop subjects on questions regarding software working in Table V. The average percentage of correct answers before the workshop is 83.3%, and it decreases by 19.0 points to 64.3% after the workshop.

RQ4. Is it more effective to learn agile principles through selected representative workshops than through self-study?

To answer this question, we compare the difference in degree of mastery between workshop subjects and self-study subjects. We first establish that there are statistically no differences between workshops subjects and self-study subjects (4) (5). Then, we compare the percentages of correct answers before and after the workshops or self-study (6) (7),

and analyze the difference in degree of mastery to determine whether workshops are more effective than self-study (8) (9).

(4) Change in the percentage of correct answers of self-study subjects on questions regarding the role of team

The percentages of correct answers of self-study subjects on questions regarding the role of team are shown in Table VI. The average percentage of correct answers before the workshop is 48.4%, and it increases to 56.3% after the workshop. The average increase is 7.8 points. We show the change in the percentage of correct answers in a box plot in Figure 6.

(5) T-test comparing the mean percentages of part 1 of first-workshop and self-study subjects

The alternative hypothesis and null hypothesis of the t-test are given next. Alternative hypothesis is that there are differences in the average percentage of correct answers of first-workshop and self-study subjects. Null hypothesis is that there are no differences in the average percentage of correct answers of first-workshop and self-study subjects. We show the results of the t-test in Table VII. The rejection region is bigger than 10%. Therefore, the null hypothesis is not aborted, and the alternative hypothesis is not realized.

(6) T-test comparing the mean percentages before and after the first workshop

We already showed the results of the t-test in Table IV. The rejection region is smaller than 10%. Therefore, the null hypothesis is aborted, and the alternative hypothesis is realized.

(7) T-test comparing the mean percentages before and after the self-study

The alternative hypothesis and null hypothesis of the t-test comparing the mean percentages before and after the self-study are given next. Alternative hypothesis is that there are differences in the average before and after the workshop. Null hypothesis is that there are no differences in the average before and after the self-study. We show the results of the t-test in Table VIII. The rejection region is bigger than 10%. Therefore, the null hypothesis is not aborted, and the alternative hypothesis is not realized.

TABLE III. PERCENTAGES OF CORRECT ANSWERS OF FIRST-WORKSHOP SUBJECTS (1)

Subject	Part 1(%)	Part 2(%)	Changes(pt)
WS1	12.5	75.0	62.5
WS2	50.0	100.0	50.0
WS3	25.0	50.0	25.0
WS4	50.0	100.0	50.0
WS5	75.0	75.0	0.0
Average	42.5	80.0	37.5

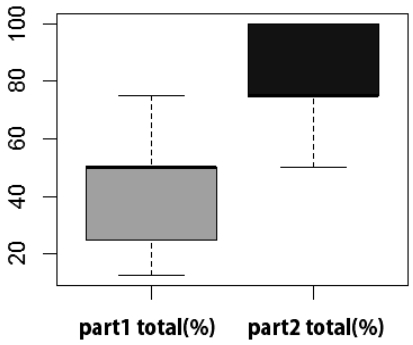

Figure 5. Box Plot of the Percentage of Correct Answers of First-Workshop Subjects

(8) T-test comparing the mean percentage changes of first-workshop and self-study subjects

The alternative hypothesis and null hypothesis of the t-test comparing the mean changes in the percentage of correct answers of first-workshop subjects and of self-study subjects are given next. Alternative hypothesis is that there are differences in the changes in the percentage of correct answers between workshop and self-study subjects. Null hypothesis is that there are no differences in the changes in the percentage of correct answers between workshop and self-study subjects. We show the results of the t-test in Table IX. We can see that the rejection region is smaller than 10%. Therefore, the null hypothesis is aborted, and the alternative hypothesis is realized.

(9) Change in the percentage of correct answers of self-study subjects on questions regarding software working

We show the percentage of correct answers of self-study subjects on questions regarding software working in Table X. The average percentage of correct answers before the workshop is 83.3%, and it decreases by 36.0 points to 47.3% after the workshop.

TABLE IV. T-TEST COMPARING THE MEAN PERCENTAGES BEFORE AND AFTER THE FIRST WORKSHOP (2) (6)

	Before WS	After WS
Average	42.5	80
Variance	593.75	437.5
Number of observations	5	5
Pearson correlation	0.398541	
Average difference between hypotheses	0	
Degrees of freedom	4	
t	-3.3541	
P(T<=t) One side	0.01423	
t Boundary value One side	2.131847	
P(T<=t) Both sides	0.02846	
t Boundary value Both sides	2.776445	

TABLE V. PERCENTAGES OF CORRECT ANSWERS OF SECOND-WORKSHOP SUBJECTS (3)

Subject	Part 1(%)	Part 2(%)	Changes(pt)
WS1	66.7	78.6	11.9
WS2	100.0	50.0	-50.0
Average	83.3	64.3	-19.0

TABLE VI. PERCENTAGES OF CORRECT ANSWERS OF SELF-STUDY SUBJECTS ON QUESTIONS REGARDING THE ROLE OF TEAM (4)

Subject	Part 1(%)	Part 2(%)	Changes(pt)
Self 1	62.5	50.0	-12.5
Self 2	25.0	50.0	25.0
Self 3	62.5	50.0	-12.5
Self 4	37.5	75.0	37.5
Self 5	25.0	50.0	25.0
Self 6	50.0	50.0	0.0
Self 7	62.5	50.0	-12.5
Self 8	62.5	75.0	12.5
Average	48.4	56.3	7.8

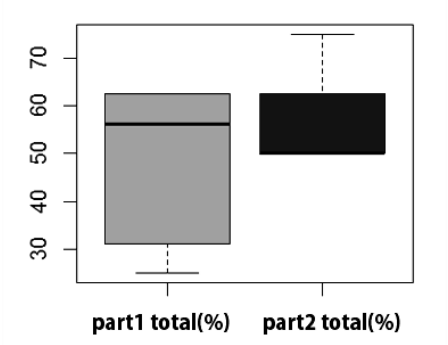

Figure 6. Box Plot of the Percentage of Correct Answers of Self-Study Subjects

TABLE VII. T-TEST COMPARING THE MEAN PERCENTAGES OF PART 1 OF FIRST-WORKSHOP AND SELF-STUDY SUBJECTS (5)

	Before WS	Before Self
Average	42.5	48.4375
Variance	593.75	287.3884
Number of observations	5	8
Pearson correlation	398.7926	
Average difference between hypotheses	0	
Degrees of freedom	11	
t	-0.52154	
P(T<=t) One side	0.306165	
t Boundary value One side	1.795885	
P(T<=t) Both sides	0.612329	
T Boundary value Both sides	2.200985	

TABLE VIII. T-TEST COMPARING THE MEAN PERCENTAGES BEFORE AND AFTER SELF-STUDY (7)

	Before Self	After Self
Average	48.4375	56.25
Variance	287.38839	133.9286
Number of observations	8	8
Pearson correction	0.056888	
Average difference between hypotheses	0	
Degrees of freedom	7	
t	-1.106244	
P(T<=t) One side	0.152592	
t Boundary value One side	1.8945786	
P(T<=t) Both sides	0.3051839	
t Boundary value Both sides	2.3646243	

TABLE IX. T-TEST COMPARING THE MEAN PERCENTAGE CHANGES OF FIRST-WORKSHOP AND SELF-STUDY SUBJECTS (8)

	WS	Self-Study
Average	37.5	7.8125
Variance	625	398.9955
Number of observations	5	8
Pearson correlation	481.179	
Average difference between hypotheses	0	
Degrees of freedom	11	
t	2.373989	
P(T<=t) One side	0.018445	
t Boundary value One side	1.795885	
P(T<=t) Both sides	0.036891	
t Boundary value Both sides	2.200985	

TABLE X. PERCENTAGES OF CORRECT ANSWERS OF SELF-STUDY SUBJECTS ON QUESTIONS REGARDING SOFTWARE WORKING (9)

Subject	Part 1(%)	Part 2(%)	Changes(pt)
Self 1	33.3	57.1	23.8
Self 2	66.7	35.7	-31.0
Self 3	66.7	35.7	-31.0
Self 4	100.0	64.3	-35.7
Self 5	100.0	57.1	-42.9
Self 6	100.0	57.1	-42.9
Self 7	100.0	35.7	-64.3
Self 8	100.0	35.7	-64.3
Average	83.3	47.3	-36.0

B. Discussion

We show the summary of our experimental results in Figures 7 and 8. In these figures, the gray boxes show the percentages of correct answers, the square boxes show the t-test results, and the arrows show the changes in the percentages of correct answers.

RQ3. Is it possible to learn agile principles through selected representative workshops?

The average percentage of correct answers increases by 37.5 points from 42.5% to 80.0% after the first workshop, and the t-test of the means indicate that there is a difference between the average values before and after the first workshop. In contrast, the average percentage of correct answers decreases by 19.0 points from 83.3% to 64.3% after the second workshop. We believe this disparity is caused by an issue with the agile mind checks, detailed in the next section.

Even though the percentage of correct answers decreases after the second workshop on software running, it increases after the first workshop, and the t-test of the means shows that there is a difference in the percentage of correct answers before and after the first workshop. This demonstrates that it is possible for learning agile principles, at least about the role of team, through workshops.

RQ4. Is it more effective to learn agile principles through selected representative workshops than through self-study?

According to our results, there is no difference among the subjects in their degree of mastery of agile principles prior to attending the workshops or conducting self-study. First-workshop subjects increased their rate of correct answers through the workshop, and the t-test demonstrates that there is a difference in the means before and after the workshop. On the other hand, self-study subjects also increased their rate of correct answers through self-study, but the t-test shows that there is no difference in the means before and after self-study.

Moreover, the amount of increase is greater for first-workshop subjects at 37.5 points than for self-study subjects at 7.9 points. The t-test of the average percentage changes also shows that there is a difference between first-workshop and self-study subjects.

Additionally, the amount of decrease in the percentage of correct answers is smaller for second-workshop subjects at 19.0 points than for self-study subjects at 30.0 points in the software working domain.

All of the above demonstrate that it is more effective to learn agile principles through one of representative workshops than through self-study regarding the agile mind check score.

C. Threats to Validity

(1) Agile mind check

Agile mind check is a set of questions based on the Agile Manifesto, used to check the degree of mastery of agile development principles. Unfortunately, however, the questions are not evenly distributed among all aspects of agile development.

For example, in the preliminary agile mind check, there are only three questions on software running, which results in a high percentage of correct answers in general. In the final agile mind check, however, there are fourteen questions on software running, and some of the questions had an extremely low answer rate. As a result, the percentage of correct answers is reduced for both second-workshop and self-study subjects.

This uneven distribution of questions poses the possibility of the percentage of correct answers in a certain domain not accurately reflecting the degree of mastery of that domain. However, this issue affects both the workshop and self-study subjects equally. Therefore, we assume that this issue does not affect our results.

The agile mind check used in our study includes questions taken from samples published on the Internet [28][29]; however the agile mind check also includes our own original questions. Although we carefully prepared these questions but their validity could be a validity threat of the experiment.

We sorted the questions into the different domains, but we don't see how that would be a threat to the validity of the agile mind checks.

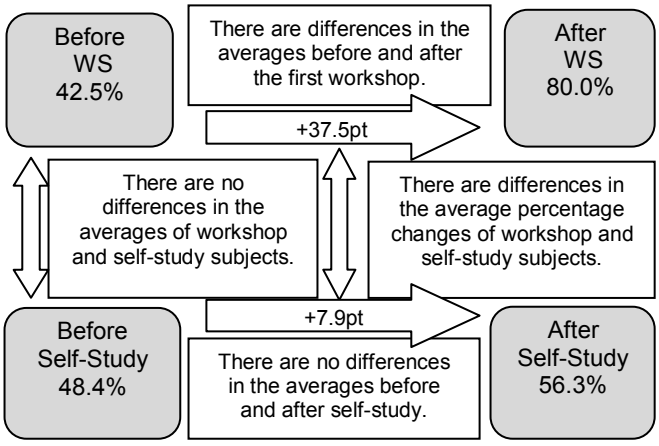

Figure 7. Summary of Average Percentages and T-Test Results of First-Workshop and Self-Study Subjects in the Role of Team Domain

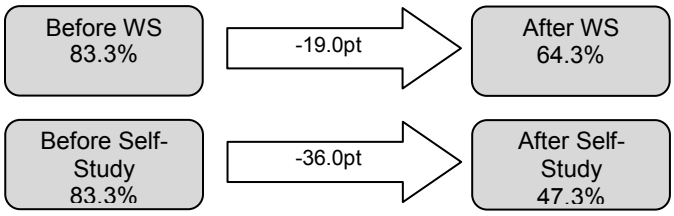

Figure 8. Summary of Average Percentages of Second-Workshop and Self-Study Subjects in the Software Working Domain

(2) Subjects

In this experiment, we examine only 15 subjects (5+2 workshop subjects and 8 self-study subjects). For a more accurate result, we should increase the number of subjects. In our case, the effect of one person is high, and the results may be affected by one additional subject. Moreover it is better that each group consists of the same number of subjects.

The self-study was conducted in such a way that the subjects were responsible for keeping their own time for both the study period and the agile mind check afterwards. We assume that all subjects complied with the rules regarding time, but we have no way of checking that.

V. RELATED WORK

A. Systematic mapping and agile development

Petersen et al. introduces how to conduct a systematic mapping study in software engineering [20]. They also compared systematic maps and systematic reviews to clarify how to choose between them. This comparison leads to a set of guidelines for systematic maps, which we use in our study to survey the trend of agile development workshops.

Wohlin presents the results of systematically reviewing the current research literature on the use of agile practices and lean software development in global software engineering [13]. The resulting systematic map indicates the need for future research on how to integrate all experiences and practices in a way to assist practitioners when setting up non-collocated agile projects. In our study, we identify the trends of agile development workshops, and reveal that some areas of agile development are hardly being covered by workshops.

Sharma et al. conducted a systematic mapping of agile testing [16], and investigated five research questions: which authors are most active in agile testing; what is agile testing used for; what types of paper tend to be published in this field; how do practitioners and academics contribute to research in this field; and what tools are used to conduct agile testing? In the same manner, we perform systematic mapping on web sites that include agile development workshops.

B. Workshops and software engineering

A workshop was previously held on Human and Social Factors in Software Engineering [1], which combined approaches of software engineering with social science. The workshop looked at software engineering from a number of perspectives, including those of agile methods and communication theory, in order to point out solutions and conditions for human-centered software engineering. In our paper, we take some of the research presented at the workshop further, and survey the effectiveness of participating in workshops to learn agile principles.

Ali suggests some measures that can help improve software engineering education to better prepare software engineering students for professional careers [10]. In order to better equip software engineers for these roles, software engineering education has to be constantly reviewed and innovations must be introduced. Similarly, agile development education also needs to be reviewed, and innovative learning methods must be introduced. We suggest workshops as an effective tool for agile development education and analyze their effectiveness.

Reina Mori has presented design processes of workshops for learning [19]. Mori elucidates the differences between an inexperienced and a veteran workshop facilitator. In our study, we refer processes of workshops for learning written by Reina Mori to define the content of our workshops in experiment.

C. Education and agile development

Layman et al. describes an initiative at North Carolina State University in which the undergraduate software engineering class was restructured in layout and in presentation [9]. The change was made from a lecture-based coursed that followed the waterfall method to a lab-oriented course emphasizing practical tools and agile development. Layman examined the new course layout for learning software engineering, but we examine especially workshops for learning agile principles.

VI. CONCLUSION AND FUTURE WORK

A. Conclusion

In this study, we compared the effectiveness of self-study with that of attending workshops for learning agile principles. Self-study is the most common way of learning agile principles, but workshops are gaining popularity. We conducted an experiment to demonstrate that it is effective to learn agile principles through workshops. As mentioned in Chapter IV, we measured the subjects' degree of mastery of agile principles using the agile mind check consisting of 30 questions, and compared the results for self-study and workshop subjects.

We classified the agile mind check questions into different domains, and conducted a comparative experiment of workshop and self-study subjects. For the first workshop, the average percentage of correct answers increased after the workshop, and this was confirmed by the t-test of mean values. Furthermore, the difference in the percentage of correct answers before and after the workshop or self-study was greater for first-workshop subjects than for self-study subjects, which was also confirmed by a t-test of the mean values. This shows that the workshop was more effective than self-study. The second workshop was on software working, but could not, the number of samples compared to the average person who originate from a workshop will be greater than those caused by self-taught in the comparison of the percentage of correct answers at least also it is that I was able to be confirmed.

We have shown that it is possible to learn agile principles through workshops, and that participating in workshops can be more effective than studying alone. In this research, we have contributed to the following in relation to the effectiveness of agile development workshops.

- First, we demonstrate that attending one of representative workshops is more effective than self-study for learning agile principles.
- Second, we demonstrate that one of representative workshops is effective in learning agile principles. These two contributions are made by analyzing the common workshops with Systematic Mapping, and by performing the experiment as written in Chapter IV.
- Our third contribution is that we suggest the agile mind check as a method to measure the degree of mastery of agile principles. In this experiment, we used this check to major determine the subjects' degree of mastery in subjects. This is expected to become a more effective check in the future.

B. *Future prospects*

In this study, we were able to confirm that one of workshops is effective in learning agile principles. However, in order to demonstrate workshop effectiveness even further, the following improvements can be made to our experimental method.

- Increase the number of subjects
- Analyze the effectiveness of other existing workshop processes and types
- Analyze the educational results during actual software development

In addition, as mentioned in Section 5.4, the agile mind check used in this study has some issues regarding the even distribution of questions. Therefore, the following can be done to improve the agile mind check.

- Conduct a review of the issues of the agile mind check
- Use different versions and combinations of the agile mind check in our experiment

REFERENCES

[1] Michael John, Frank Maurer, Bjørnar Tessem, "Human and social factors of software engineering: workshop summary", ACM SIGSOFT Software Engineering Notes Volume 30 Issue 4, 2005.

[2] Jonathan Rasmusson, Naoto Nishimura, Shintarou Kadotani, Shuhei Kondo, Takumi Tsunokake, "Agile Samurai", Ohmsha, Ltd., 2012.

[3] Hideo Koizumi, Koji Yoshida, Shuichi Tsuji, Tsuyoshi Nakajima, "Software development", Ohmsha, Ltd.,2003.

[4] Scott Ambler, "Agile Modeling: Effective Practices For eXtreme Programming and the Unified Process", John Wiley & Sons Inc, 2002.

[5] Chrage Rahman, Shinziro Kodaka, Naoki Matsuda, Noriko Ochi, "Agile development for the first time", Nikkei BP, 2004.

[6] Kent Bech, Yoshihide Nagase, "XP Introduction of eXtream programming Embrace change", second ed, Pearson Kirihara, 2005.

[7] Taku Fuji, "Ogis-ri White Paper on Agile", Ogis-ri Agile Development Center Technology Department, 2012.

[8] Kimitoshi Hori, Akira Kato, "Workshop Design Making forum for dialogue that spun the knowledge", Nikkei Publishing Inc., 2012.

[9] Lucas Layman, Travis Cornwell, Laurie Williams, "Personality types, learning styles, and an agile approach to software engineering education", SIGCSE '06 Proceedings of the 37th SIGCSE technical symposium on Computer science education, 2006.

[10] Muhammad Raza Ali, "Imparting effective software engineering education", ACM SIGSOFT Software Engineering Notes Volume 31 Issue 4, 2006.

[11] Melnik, G., Maurer, F., "A cross-program investigation of students' perceptions of agile methods", Software Engineering, 2005. ICSE 2005. Proceedings. 27th International Conference on, 2005.

[12] Emmanuel Letier, Joao Araujo, Ricardo Gacitua, Pete Sawyer, "First International Workshop on Agile Requirements Engineering: Workshop Report", The fist international workshop on Agile Requirements Engineering, 2011.

[13] Wohlin, C., "Agile Practice in Global Software Engineering – A Systematic Map", Global Software Engineering (ICGSE) 2010 5th IEEE International Conference, 2010.

[14] Sharma, A., Ferreira, J., Maurer, F., "Agile Testing: Past, Present, and Future – Charting a Systematic Map of Testing in Agile Software Development", Agile Conference (AGILE) 2012, 2012.

[15] Ivonei Freitas da Silva, Paulo Anselmo da Mota Silveira Neto, Pádraig O'Leary, Eduardo Santana de Almeida, Silvio Romero de Lemos Meira, "Agile software product lines: a systematic mapping study", Special Issue: Agile Product Line Engineering, 2011.

[16] Sharma, A., Ferreira, J., Maurer, F., "Agile Testing: Past, Present, and Future – Charting a Systematic Map of Testing in Agile Software Development", Agile Conference (AGILE) 2012, 2012.

[17] Takeshi Suzuki, Sakutaro Yamada, "Mathematical statistics - Learn from basic data analysis -", Uchida Rokakuho, 2008.

[18] Noriyuki Baba, Shigeru Hisaikei, "Stochastic - Campus seminar -", Masema Publiser, 2008.

[19] Reina Mori, "Research on design processes of workshops for learning", Journal of Japan Society for Educational Technology Volume 31 Issue 4, 2008.

[20] Kai Petersen , Robert Feldt , Shahid Mujtaba , Michael Mattsson, "Systematic Mapping Studies in Software Engineering", Electronic Workshops in Computing, 12th International Conference on Evaluation and Assessment in Software Engineering, 2008.

[21] Ward Cunningham, Kenji Hiranabe, "Manifesto for Agile Software Development", http://agilemanifesto.org, 2001.

[22] TastyCupcakes.org, http://tastycupcakes.org/

[23] SCRUMPHONY-SCRUM, KANBAN AND OTHER USEFUL STUFF, http://blog.scrumphony.com/2010/07/whats-your-favorite-agile-game/

[24] Agile Development Center, OGIS-RI Technology Department, Inc. Taku Fujii, Introduction to Agile development to enhance product capabilities,

http://www.ogis-ri.co.jp/event/docs/1200880_Agile.pdf

[25] Information-technology Promotion Agency (IPA), Software Engineering Center Technology Division (SEC), Hiroyuki Yamashita, IPA/SEC Point of the " Activity report of non-waterfall-style development WG", http://sec.ipa.go.jp/seminar/2011/20111004.html

[26] Culture Faculty beta / Agile coach, Takeshi Kakeda, Introduction to Agile for business acceleration, http://www.slideshare.net/kkd/ss-10057840

[27] Information-technology Promotion Agency (IPA), Survey about expansion of the application areas and the spread factor of non-waterfall-style development,

http://sec.ipa.go.jp/reports/20120611.html

[28] AgileExams.com, Agile Certification Sample Exam Questions, http://www.agileexams.com/sample/

[29] DSDM CONSORTiUM, Sample Questions, http://www.dsdm.org/prof-development/sample-questions/

[30] Shota Suzuki, Hironori Washizaki, "Agile Workshop", Waseda University, Reliable Software Engineering Laboratory (Washizaki Lab). http://www.washi.cs.waseda.ac.jp/agile_workshop/