Applying Action Design Research (ADR) to Develop Collaboration Virtual Programming Laboratory as Supporting System For Student Centered Learning

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Abstract. The development of technology is currently growing very rapidly. The change of information and communication technology (ICT) to ubiquitous technology is inevitable. This affects the development of the world of education, where the current learning method that is being promoted by the government is a student-based learning system or known as the Student Centered Learning (SCL). ADR is one of Information systems design science research frameworks. To produce a perspective design of knowledge through four main stages: Problem Formulation, Building Intervention and Evaluation (BIE), Reflection and Learning, Formalization of Learning, ADR is a combination of Action Research (AD) with Design Science Research (DSR). In learning of programming required laboratory infrastructure that can support in terms of programming practice. Growth of learning students is not aligned with the extension of supporting infrastructure, in this case the laboratory, especially the programming laboratory. In a case study at Widyatama University, along with the change of teaching and learning system, the learning media also changed. The current learning media that is e-learning, can only support theoretical learning but not support for learning in practice. This project is done by two domains: Teaching Learning Office (TLO) as the department that responsible for current e-learning, and An informatics study center developing a virtual laboratory. At the evaluation stage, testing is qualitative for users, as well as testing in Alpha and Betha. Alpha testing is done intranet on VPL-SCM, whereas on Betha testing done internet on VPL_SCM. Conclusion is an important aspect when designing IT artifacts is the dynamics between plan design and use context. The ADR interaction focuses on researchers, practitioners and end users during the design process and is strongly collaborative-oriented. The evaluation stage in ADR is a continuous stage, so the development of IT artefact can be continuously adjusted through repeatable processes, so virtual programming laboratory can be implemented properly as a supporter of existing e-learning system.

1. Introduction
The development of technology is currently growing very rapidly. The change of information and communication technology (ICT) to ubiquitous technology is inevitable [1]. This affects the development of the world of education, where the current learning method that is being promoted by the government is a student-based learning system or known as the Student Centered Learning (SCL) In the SCL learning model, students play an active role in learning. This proved to be more effective in achieving competence and learning [2]. In programming learning required laboratory infrastructure that
can support in terms of programming practice. The growth of the number of students who learn is not aligned with the extension of supporting infrastructure, in this case the laboratory, especially the programming laboratory. In a case study at Widyatama University, along with the change of teaching and learning system, the learning media also changed. The current learning media is e-learning. E-learning that exist today can only support theoretical learning but not yet support for learning in practice, especially for informatics study program.

To support the learning system based on e-learning programming then the development required. The development needed at this time is e-learning that can support teaching and learning process, especially programming practice, that is virtual programming laboratory. In addition to virtual labs, in the process of learning programming practice required a application of source code management repository, so that the source code that has been studied well controlled and stored.

With the support of the development of internet technology today that 4G makes internet access becomes faster. And Indonesia is the 6th largest internet user in the world [3]. The presence of 4G LTE connections at the end of 2015, Indonesia successfully entered the ranks of the top five countries in Asia Pacific with the highest average Internet access speed, reaching 79.8 Mbps [4]. Supported by good access, the use of e-learning technology as a virtual classroom media can also be developed into a Virtual Programming Laboratory as a support for Student Centered Learning (SCL) in practical learning.

Action Design Research (ADR) is an information systems design science research framework that can be used in the process of building virtual programming laboratory to support the existing e-learning process at Widyatama University

2. Action Design Research (ADR)
ADR is one of Information systems design science research frameworks. To produce a perspective design of knowledge through four main stages [5] :

1. Problem Formulation
2. Building, Intervention and Evaluation (BIE)
3. Reflection and Learning
4. Formalization of Learning

ADR is a combination of Action Research (AD) with Design Science Research (DSR).

![Figure 1. ADR Method](image)

A. Problem Formulation
Problem formulation is the stage of identifying and conceptualizing research opportunities based on existing theory and technology[6]. Stage of problem formulation refers to two principles:

- p.1. Practice Inspired Research
- p.2. Theory – Ingrained Artifact
P1. Practice Inspired Research

The first principle emphasizes that applied research should be based on real-world problems. This idea is similar to problem-based research. This approach helps ensure the relevance of the domain and paves the way for in vivo evaluation of two core tenets of design studies [7].

P2. Theory Ingrained Artifact

The second principle emphasizes the importance of design theory and domain theory in informing the researchers’ understanding of problems and solutions, and in helping guide the design process. This principle aims at the same learning stage in the design study methodology [7].

B. Building, Intervention and Evaluation (BIE)

Carried out as an iterative process in a target environment, the BIE phase interweaves the building of the artefact, intervention in the organization, and evaluation, and the outcome of the BIE stage is the realized design of the artefact [5, 8]. This stage is guided by:

p.3. Reciprocal Shaping
p.4. Mutually Influential Roles
p.5. Authentic and Concurrent Evaluation

Figure 2. The Generic Schema for IT-Dominant BIE

P.3. Reciprocal Shaping

This principle emphasizes the inseparable influences mutually exerted by the two domains: the IT artifact and the organizational context. The ADR team may engage in recursive cycles of decisions at finer levels of detail in each domain [5].

P.4. Mutually Influential Roles

This principle shows the importance of mutual learning among the different project participants. Action Design Research (ADR) bring their knowledge of the progress of theory and technology, while practitioners bring practical hypotheses and knowledge of organizational work practices. These perspectives and contributions can compete with each other or complement each other [5, 9].

P.5. Authentic and Concurrent Evaluation

This principle emphasizes a key characteristic of ADR: evaluation is not a separate stage of the research process that follows building. Instead, decisions about designing, shaping, and reshaping the ensemble artifact and intervening in organizational work practices should be interwoven with ongoing evaluation, although their specific format may vary based on the BIE form [5].
C. Reflection and Learning

Task in the reflection and Learning is:

1. Reflect on the design and redesign during the project.
2. Evaluate adherence to principles.
3. Analyze intervention results according to stated goals.

This stage draws on one principle:

*p.6 Guide Emergence*

to capture a vital trait of ADR: the interplay between the two seemingly conflicting perspectives. It emphasizes that the ensemble artifact will reflect not only the preliminary design [5].

D. Formalization of Learning

The situated learning from an ADR project should be further developed into general solution concepts for a class of field problems. This stage draws on one principle: p.7 Guide Emergence 5.

*p.7 Generalized Outcomes*

Generalization is challenging because of the highly situated nature of ADR outcomes that include organizational change along with the implementation of an IT artifact.

3. Applying Action Design Research (ADR)

A. Formalization of Learning

The formulation of the problem discussed in this research is how to develop framework of virtual programming laboratory that collaborate with application of web-based source code management repository that can support in learning process of Student Centered Learning practicum without having to build from scratch but develop from e-learning media already there and is still used today at Widyatama University.

*p1. Practice Inspired Research*

In learning of programming required laboratory infrastructure that can support in terms of programming practice. Growth of learning students is not aligned with the extension of supporting infrastructure, in this case the laboratory, especially the programming laboratory. In a case study at Widyatama University, along with the change of teaching and learning system, the learning media also changed. The current learning media that is e-learning, can only support theoretical learning but not support for learning in practice.
To support the learning system programming with e-learning based development is required. The development needed at this time is e-learning that can support teaching and learning process, especially programming practice, that is virtual programming laboratory. In addition to the virtual lab, in the process of learning programming practice required a application of source code management repository, so that the source code that has been studied well controlled and stored.

**P2. Theory Ingrained Artifact**
For this stage the authors have conducted literature studies for benchmarks from previous research on the development of Virtual Classroom [12], Smart Laboratory [10] and Source Code Management Repository [13].

**B. Building, Intervention and Evaluation (BIE)**

**P3. Reciprocal Shaping**
This project is done by two domains:
1. Teaching Learning Office (TLO) as the department that responsible for current e-learning, and
2. An informatics study center developing a virtual laboratory.

**P4. Mutually Influential Roles**
The principle of mutually influential roles points to the importance of mutual learning among the different project participants and it was essential throughout the project because each partner has his own specific knowledge and expertise and in order to shape the User-friendly process and the Active Projects and online community section the research team needed constant and active input from the corporate partner [11].

**P5. Authentic and Concurrent Evaluation**
Below is the development and testing phase of the Virtual Programming Laboratory framework based on Source Code Management (VPL-SCM).

![Diagram showing the IT Dominant BIE dalam Framework VPL-SCM](image)

**Figure 4. IT Dominant BIE dalam Framework VPL-SCM**

At this stage of the evaluation, testing is qualitative for users, as well as testing in Alpha and Beta. Alpha testing is done intranet on VPL-SCM, whereas on Beta testing done internet on VPL_SCM.
C. Reflection and Learning

P.6 Guided Emergence
The main tasks in the Reflection and Learning Stage are to: reflect on the design and redesign during the project, evaluate adherence to principles and analyze intervention results according to stated goals. The project is at this moment in the reflection and learning stage and the research team is constantly analyzing and evaluating the results obtained through internal and external testing according to the short term and long term goals of the project [11].

At this stage will be implemented to be tested if any changes will be made to the implementation of the framework implementation of the Virtual Programming Laboratory Collaboration with Source Code Management (SCM) for Open Source Based Programming Language as Supporting Student Centered Learning (VPL-SCM) Learning Method.

D. Formalization of Learning
The main tasks in the Formalization of Learning Stage are to: abstract the learning onto concepts for a class of field problems, share outcomes and assessment with practitioners, articulate outcomes as design principles, articulate learning in light of theories selected and formalize results for dissemination [11].

P.7 Generalized Outcomes
This stage is the final step of the Action Design Research (ADR) method of VPL-SCM or the Collaboration framework of Virtual Programming Laboratory with Source Code Management (SCM) For Open Source Based Programming Language as Supporting Student Centered Learning (SCL) Learning Method will be applied directly with users involved in a lab scale.

4. Conclusion
Based on the results that have been to Develop Collaboration Virtual Programming Laboratory as Supporting System Student Centered Learning, it can be concluded that the ADR method selected:

1. an important aspect when designing IT artifacts is the dynamics between plan design and use context.
2. The ADR interaction focuses on researchers, practitioners and end users during the design process and is strongly collaborative-oriented.
3. The evaluation stage in ADR is a continuous stage, so the development of IT artefact can be continuously adjusted through repeatable processes, so virtual programming laboratory can be implemented properly as a supporter of existing e-learning system.

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