

# MATH E-LEARNING QUESTION SPECIFICATION AND XML EXPORTER FOR STACK BY USING VISUAL PROGRAMMING LANGUAGE

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## Abstract

In recent years, automatic mathematics e-assessment systems, namely math e-learning systems, have been attracting interests, but the contents are developed independently in each system. We proposed mathematics e-learning question specification (MeLQS) as a common base for authoring questions in math e-learning systems. If data in MeLQS format can be exported to each system, sharing contents between different systems is facilitated. As a first stage, we developed an XML exporter for STACK by using visual programming language and the exported data can be imported to question bank of Moodle as a STACK question type.

## Introduction: what is MeLQS

- In response to the increasing demand of on-line testing in mathematics and scientific subjects, there have been developed several mathematics e-learning systems in which mathematical expressions as answers are automatically assessed.
- However, questions of mathematics on-line testing are developed independently in each system.
- If contents were shared with each other, math e-learning could be more effectively used and be promoted.
- In order to realize it, we proposed **mathematics e-learning question specification (MeLQS)** as a common base for authoring questions in math e-learning systems (Kawazoe et al., 2019).
- MeLQS consists of two specifications: **concept design** and **implementation specification**.
  - Concept design is a specification that describes a teacher's idea with mathematics teacher's language, not with programming language.
  - Implementation specification is a specification that describes the algorithm of the concept design using visual programming language.
- Our goal is to provide questions based on MeLQS to be implemented to any systems.

## XML exporter for STACK

- In the implementation specification of MeLQS, three algorithms are defined:
  - how to generate mathematical expressions embedded in a question text
  - how to generate an answer example
  - how to mark students' answers.
- The user interface to author the algorithms is developed by using block/visual programming language based on Blockly (Google, 2019) and each block represents mathematical functions or mathematical procedure.
- In order for questions based on MeLQS to be implemented to each math e-learning system, implementation specification data should be exported as a specific format suitable for each system.
- **As a first stage, we developed an XML exporter for STACK** (Sangwin, 2013). The functions and procedures defined by blocks are converted in the STACK style and they are combined to be exported as XML format.
- The exported data can be imported to the question bank of Moodle as a STACK question type.
- <https://melqs.org>

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## Concept design

- Subject/course/learning unit: mathematics(college)/linear algebra/Lines and Planes in Space
- Title: Equation of a plane
- The aim of the question: Confirm student's understanding of how to find the equation of a plane passing through points in space.
- Question text

Find the equation of a plane passing through the three points (1,2,0), (1,1,-1), (2,1,1). (Answer in the form of  $\square = 0$ .)

[Answer column] \_\_\_\_\_ = 0

- Answer example:  $2x+y-z-4=0$
- Feedback:

No	Details	Feedback	Score (%)	Remarks
1	It is an equation equivalent to the correct answer example.	Correct answer.	100	Substitute the coordinates of 3 points for x, y, z of the user's answer and check if it becomes 0.
2	The coefficients of x, y, and z are all 0.	A constant is entered in the answer column, and it is not a plane equation.	0	Check if the x, y, z coefficient list of the user's answer is {0,0,0}.
3	Correct answer only for the coefficients of x, y, z. (Incorrect answer only for the constant term.)	The coefficients of x, y, z are correct, but the constant term is incorrect.	50	Check if the rank (rank of the matrix) is 1 by using {the coefficient list of x, y, z of the user's answer, the coefficient list of x, y, z of the correct answer} as a 2x3 matrix.
4	Other than those above.	Incorrect answer. Let's review the calculation again.	0	

## Implementation specification

問題生成処理 Question generation process

指定ランクのランダムな行列の生成 ランク: 3 行数: 3 列数: 3 ランダムリスト 以下を使ってリストを作成: 0 をセット

Generate a random matrix of the specified rank Generate a list The list is set

↑ Get a specific row in a matrix 行列 MR3 をセット

Get a specific row in a matrix 行列 MR3 をセット

Get a specific row in a matrix 行列 MR3 をセット

Convert row vector to list Pt1 をセット

Convert row vector to list Pt2 をセット

Convert row vector to list Pt3 をセット

Matrix MR3 is set

List Pt3 is set

Authoring tool for implementation specification (in Japanese only)

## Export for STACK

問題の整頓 | 問題のテストとデプロイ

$[-1 \ 3 \ 0], [1 \ 1 \ -2], [0 \ 0 \ 1]$ を通る平面の方程式を求めよ. ( $\square=0$ の形で答えよ.) Find the equation of a plane passing through the three points (1,2,0), (1,1,-1), (2,1,1). (Answer in the form of  $\square = 0$ .)

\_\_\_\_\_ = 0