The design of IQF-oriented ARCS-based learning model

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Abstract. This article is a summary of some second year research reports of the three years research plan financed by Directorate of Research and Community Service (DRCS). This research aims to develop a learning model based on Attention, Relevance, Confidence and Satisfaction (ARCS) theory oriented towards Indonesian Qualification Framework (IQF) that was applied to mathematical statistics course. The stages of development of this learning model were following Plomp’s learning model development process. Plomp’s model has three stages namely: (1) preliminary stage; (2) prototype stage; (3) assessment stage. After went through experts validation process, appeal validation, and several revisions, in this second year, the implementation of this research had stepped on the beginning of assessment stage, limited trial. At this stage, technical assessment was carried out using practicality and effectiveness tests. Main focus of this stage is on field trials to find out whether the prototype model and all learning tools that have been produced are practical and effective. The field trials were conducted at three universities in North Sumatera, namely Undergraduate and Graduate School of State University of Medan, Undergraduate and Graduate School of Muslim Nusantara Medan University and Graduate School of Asahan University. This paper is only reporting the field trial’s result done in Undergraduate School of Mathematics Education Program in State University of Medan. In State University of Medan, the trial was held twice. First was in class A followed by 21 students and second was in class B followed by 40 students. From the results of the first and second trials obtained that all of the learning tools consist of student text book, lecturer hand book, student work sheets, and other supporting tools indicated high validity. Moreover, there is an enhancement of students’ ability to understand about mathematical statistics. Highest score in the first trial significantly increased from 80.5 to 94.5 in the second trial. While lowest score also significantly increased from 40.5 to 58.0 and average score increased from 63.5 to 74.4 in the second trial.

1. Introduction
Improving learning outcomes, as planned, requires an improvement in learning process. Good quality learning process becomes a necessity. Government has designed various efforts to improve the quality of human resources in Indonesia. One of the steps is developing learning tools as done by Putri et al. [1] which can increase students learning outcomes up to 85%. This is in line with several researches research results which essentially find out that developing learning model and tools can improve students’ achievement [2-8]. Another step that has been announced is to revise the curriculum at all education levels including higher education [9]. Currently being implemented a curriculum oriented towards Indonesian Qualification Framework (IQF). It is important to implement a new curriculum as a complement to the curriculum that currently on going [10-14]. Problem is how important and
compatible is this curriculum for courses in college. Some curricula that have been implemented in universities in Indonesia, even in same study program and course, are rarely similar. It also happens with textbooks used by students in the same study program and course. This might lead to differences in its graduates’ competency. This condition urges equalization of perception and curriculum in the same study program and course. The equalization is expected to improve the competency of graduates.

In the implementation in the classroom, a guideline is needed to guide lecturers effectively lead the learning process. Therefore, a design of learning model is needed to support the IQF-oriented curriculum that has been proclaimed by the government. The proper design is a learning model based on Attention, Relevance, Confidence and Satisfaction (ARCS) theory which is integrated with IQF in such a way that it can improve students’ competency in certain courses. Attention plays important role in learning process. Without full and earnest attention, it is impossible to get high achievements. As well as relevance, this has not been a main concern for some lecturers to improve the relevance of a topic with its application in daily basis. Next, confidence is an attitude that must be possessed by every lecturer and student about topics they studied. Purposes and benefits of a topic must be truly understood. Satisfaction is an important part of understanding a topic. Satisfaction is related to a feeling of pride of the results achieved in learning. The pride can encourage and strength then the desire to learn. Based on the description above, this research will design a learning model for mathematical statistics course which, so far, has been relatively difficult for students to understand. Aside from designing the learning model, this research also produces a mathematical statistics textbook that oriented towards IQF based on ARCS theory. Special purpose of this research is to produce a learning model oriented towards IQF based on ARCS theory that applied to mathematical statistics course.

2. Method
This research was a development research, which was designing IQF-oriented ARCS-based learning model. Development model used in this research was Plomp’s model which consists of three main stages, namely preliminary stage, prototype stage, and assessment stage.

2.1 Preliminary Stage
At the preliminary stage and partially the prototype stage, the following activities were carried out:
1. Composing Mathematical Statistics textbook for students
2. Composing lecturer handbook
3. Composing student worksheets (learning support materials)
4. Composing another instruments such as observation instrument, student and lecturer questionnaires and test instrument.

2.2 Prototype Stage
At the prototype stage and partially assessment stage, the following activities were carried out:
1. Completing the textbook, handbook, and other instruments
2. Designing the learning model
3. Validating prototype design of the learning model
4. Doing limited trial. First trial was done in class A followed by 21 students and second trial was done in class B followed by 40 students of Mathematics Education program in State University of Medan. The tested object was learning model and learning tools that are relevant to the IQF, namely routine tasks (RT), critical book report (CBR), critical journal review (CJR), mini research (MR), engineering idea (EI), and projects.

2.3 Assessment Stage
After going through experts’ validation process, appeal validation and some revisions, in this second year, the implementation of this research had stepped on the beginning of assessment stage, limited trial. In this stage, technical assessment was carried out using practicality and effectiveness tests. Main focus of this stage is on field trials to find out whether the prototype model and all learning tools that
have been produced are practical and effective. The field trials were conducted at three universities in North Sumatera, namely Undergraduate and Graduate School of State University of Medan, Undergraduate and Graduate School of Muslim Nusantara Medan University and Undergraduate School of Asahan University. This paper is only reporting the field trial’s result done in Undergraduate School of Mathematics Education Program in State University of Medan. In State University of Medan, the trial was held twice. First was in class A followed by 21 students and second was in class B followed by 40 students. The learning design development stages are presented in Figure. 1.

![Fish Bone Diagram](image)

**Figure 1.** Research Stages Shown by Fish Bone Diagram

### 3. Result and Discussion

After the learning tools developed had been approved, then, the draft would be tested. The first trial implemented for half a semester by implementing the learning model and developed tools. The first trial was held in class A followed by 21 students and second trial was held in class B followed by 40 students. From data analysis’ result in the first trial, turned out that the learning device had not been effective yet, because there were some indicators had not been achieved, namely classical achievement criteria. Students’ comprehension ability about some topics was still low. Based on analysis of the first trial, it was necessary to revise some components so that the learning tools could increase students’ comprehension ability in mathematical statistics. The result of the first trial was used as a reference to fix the learning tools. After that, a review and revision of the learning tools were carried out, the results were called *draft 2*. It would be re-tested on the next trial.

Overall, result of data analysis of the second trial showed that the tools is effective, specifically: (1) students activities met the ideal time tolerance specified; (2) students responded positively towards the tools; and (3) the result of students’ comprehension ability about mathematical statistics met the classical achievement criteria. Seen that the results of the second trial are better than the first one. This can be understood that the IQF-oriented ARCS-based learning tools used in the second trial are revised based on suggestions from the first trial. From the result of the second trial, it can be concluded that IQF-oriented ARCS-based learning tools have satisfied quality of effective learning tools. Analysis of the effectiveness of the developed learning tools in the first trial are described as follows:
3.1 Students activities in the first trial
Students activities are classified into five categories, such as: (1) read/do tasks in the worksheets, (2) ask questions to lecturer, (3) discuss in a small group, (4) listen/pay attention to lecture, (5) behave irrelevant to the learning. Average percentages of students’ activity time for each category from first meeting up to seventh meeting are 25.8%; 17.6%; 18.3%; 25.8%; and 12.5%. Average percentages of students’ ideal activity time in the first trial are shown in Table 1.

| Meeting | Percentages of students’ average ideal activity time for each category (%) |
|---------|-------------------------------------------------------------------------|
| 1       | 1  24.4 | 2      20.2 | 3      15.4 | 4      27.6 | 5      12.4 |
| 2       | 25.6 | 18.2 | 17.3 | 26.7 | 12.2 |
| 3       | 26.1 | 18.2 | 17.5 | 25.6 | 12.7 |
| 4       | 26.2 | 17.3 | 17.6 | 24.5 | 14.4 |
| 5       | 27.2 | 16.3 | 18.4 | 25.8 | 12.3 |
| 6       | 25.4 | 15.5 | 23.5 | 24.7 | 10.9 |
| 7       | 24.4 | 20.2 | 15.4 | 27.0 | 12.4 |
| % average | 25.8 | 17.6 | 18.3 | 25.8 | 12.5 |

3.2 Students responses in the first trial
Overall, average result for each response aspects are as follows: (1) 94.7% of students expressed pleasure in the learning tools; (2) 89.3% of students stated the tools and activities are new; (3) 98% of students expressed interest in participating in mathematical statistics learning; (4) 88.5% of students stated language structure in the textbook, worksheets, and test instrument are understandable; and (5) 90% of students expressed interest in the appearance of the textbook.

3.3 Students classical learning achievement of the first trial
Out of 21 students in class A, there are 7 of them (33.3%) got E, 6 of them (28.57%) got C, 8 of them (38.1%) got B, and none got A. Level of students achievement can be seen in Table 2.

| Category | Students understanding ability in mathematical statistics |
|----------|---------------------------------------------------------|
|          | Number of students | Percentage   |
| Achieved | 14                  | 66.67%       |
| Failed   | 7                   | 33.33%       |
| Total    | 21                  | 100%         |

The second trial was held in the next 7 meetings in the same semester. The second trial was held in a class of 40 students. Analysis of the effectiveness of the developed IQF-oriented ARCS-based learning tools in the second trial is described as follows:

3.4 Students activities in the second trial
Students activities in the second trial are similar to the first one, such as: (1) read/do tasks in the worksheets, (2) ask questions to lecturer, (3) discuss in a small group, (4) listen/pay attention to lecture, (5) behave irrelevant to the learning.

Average percentages of students’ activity time for each category from first meeting up to seventh meeting are 25.8%; 17.6%; 18.3%; 25.8%; and 12.5%. Average percentages of students’ ideal activity time in the second trial are shown in Table 3.
Table 3. Average Percentage of Students’ Ideal Activity Time in the Second Trial

| Meeting | 1    | 2    | 3    | 4    | 5    |
|---------|------|------|------|------|------|
| 1       | 32.5 | 12.3 | 38.4 | 13.4 | 3.4  |
| 2       | 35.6 | 10.4 | 35.6 | 12.4 | 6.0  |
| 3       | 34.5 | 12.6 | 34.5 | 14.2 | 4.2  |
| 4       | 36.1 | 12.5 | 36.1 | 12.3 | 3.0  |
| 5       | 36.2 | 14.1 | 33.4 | 10.2 | 6.1  |
| 6       | 36.4 | 10.2 | 35.4 | 12.5 | 5.5  |
| 7       | 32.5 | 12.3 | 38.4 | 13.4 | 3.4  |
| % average | 35.2 | 12.0 | 35.6 | 12.5 | 4.7  |

The explanation above provides an illustration that students are active and passionate during learning process using IQF-oriented ARCS-based learning tools. Students do more activities related to the learning than activities that are irrelevant to the learning. The amount of time students use to examine the worksheets and discuss in their groups made a conducive atmosphere, as stated by [3] that students activity in learning process will cause interaction between lecture and students or among students, that make a conducive atmosphere and every students engage in learning to the fullest.

3.5 Students’ responses in the second trial

Overall, average result for each response aspects are as follows: (1) 95.8% of students expressed pleasure in the learning tools; (2) 90.2% of students stated the tools and activities are new; (3) 96% of students expressed interest in participating in mathematical statistics learning; (4) 89.6% of students stated language structure in the textbook, worksheets, and test instrument are understandable; and (5) 90% of students expressed interest in the appearance of the textbook. According to the criteria, it can be concluded that students’ responses towards the learning tools and activities are positive. Because, more than 80% students gave positive response towards the developed mathematical statistics learning tools.

3.6 Students classical learning achievement of the second trial

Out of 40 students in class B, there is 1 of them (2.5%) got E, 12 of them (30.0%) got C, 20 of them (50.0%) got B, and 7 of them (17.5%) got A. Level of students achievement can be seen in Table 4.

Table 4. Classical Achievement Level of Students Understanding Ability in the Second Trial

| Category | Students’ comprehension ability in mathematical statistics |
|----------|----------------------------------------------------------|
|          | Number of students | Percentage |
| Achieved | 39               | 97.5%      |
| Failed   | 1                | 2.5%       |
| Total    | 40               | 100%       |

The result shows that students’ classical achievement using the developed IQF-oriented ARCS-based learning tools meet the effectiveness criteria.

3.7 Improvement of students’ ability

Improvement of students’ ability in mathematical statistics course that taught by IQF-oriented ARCS-based learning tools can be explained as follows: The analysis results of students’ improvement in the first and second trial are significantly different. In the first trial, the lowest score was 40.5 while the highest was 80.5. There is a range score of 40. The average score in this trial was 63.5. Because of the range score is lower than the average score, it can be concluded that most students are above the average.

In the second trial, the lowest score was 58.0 and the highest was 94.5, which means that the range score of the second trial was 36.5 while the average score was 74.4. Because of the range score is so much lower than the average score, it also can be concluded that most students are above the average.
The improvements of the score in the first and second trial are shown on Table 5.

| Information          | Mathematical statistics ability test in the first trial | Mathematical statistics ability test in the second trial |
|----------------------|--------------------------------------------------------|--------------------------------------------------------|
| Highest score        | 80.5                                                   | 94.5                                                   |
| Lowest score         | 40.5                                                   | 58                                                     |
| Range score          | 40.0                                                   | 36.5                                                   |
| Average score        | 63.5                                                   | 74.4                                                   |

### 3.8 Effectiveness of The Learning Model

Viewed from students’ activities in the first and second trial, it appears that all aspects of the student activity category have met the specified ideal time criteria. It can be concluded that students’ activities during the learning process have met the effectiveness criteria both in the first and second trial. Based on the result of data analysis in both trial, obtained that the average percentage of students responses in each trial is positive. It means that students feel pleased using the developed tools. Students’ responses in each trial have met the specified criteria, which is more than 80%. It shows that the developed learning tools have met the effectiveness criteria in terms of students’ responses. One of the goals obtained from this learning model development is to increase students’ comprehension ability about mathematical statistics.

### 3.9 Improvement of Students’ Comprehension Ability about Mathematical Statistics

Analyzed from the results of the first and second trial, the improvement of students’ comprehension ability is clearly visible from all aspects. The highest score in the first trial (80.5) significantly increased in the second trial (94.5). It also happens for the lowest score where in the first trial was 40.5 and the second trial was 58. The score range in the first trial (40) decreased in the second trial (36.5) while the average score in the first trial increased from 63.5 to 74.4 in the second trial.

### 4. Conclusion

IQF-oriented ARCS-based learning model applied to mathematical statistics course can increase student activities in learning, including: increasing reading activities/working in worksheets, asking questions to the lecturer, discussing in a small group, listening/paying attention to the lecturer, and decreasing irrelevant behaviors. Furthermore, IQF-oriented ARCS-based learning model applied to mathematical statistics course can increase students’ comprehension ability. The average score in the first trial increased from 63.5 to 74.4 in the second trial.

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