

## Implementation of Chemical Instrumentation Competency-Based Learning for Chemical Lecturers At Medical Laboratory Technology Program

Endang Tri Wahyuni Maharani<sup>1\*</sup>, Andari Puji Astuti<sup>2</sup>, Yusrin<sup>3</sup>

Universitas Muhammadiyah Semarang, Kota Semarang, 50273, Indonesia

\*Correspondence: [endangtm@unimus.ac.id](mailto:endangtm@unimus.ac.id)

### Abstract

**Keywords:**  
chemical  
instrumentation  
training management  
model  
competence

The research background is that the chemical instrumentation course examines all instrumentation used in health laboratory examinations according to the demands of the competence of a Health Analyst. In addition to the demands of professionalism (hard skills), the success of learning is also determined by the soft skills of the lecturers. In terms of challenges in the learning process, training is a solution to overcome these problems. The aim of this research is to analyze the factual, hypothetical and final models of chemical instrumentation training management for Chemistry Medical Laboratory Technology lecturers. The research design used Research and Development (R&D) within 3 (three) stages, namely: preliminary, development, and testing which was conducted towards the Chemistry lecturers of Medical Laboratory Technology program in Semarang City. Data collection techniques used: interviews, instruments, and documents. The feasibility of the model was tested through expert and practitioner validation tests and limited experiments through Focus Group Discussion (FGD). The research data were analyzed descriptively, quantitatively and qualitatively. The research results in several conclusions: 1) the training management model for Chemistry Medical Laboratory Technology lecturers that has been implemented so far has not been able to accommodate the aspirations of lecturers teaching chemical instrumentation material; 2) development of the design of a chemical instrumentation training management model for Chemistry Analyst lecturers includes the implementation of training, training organization, training implementation, and training evaluation which is carried out comprehensively starting from teaching materials, programs, procedures, instructors, facilities and infrastructure; and 3) the design development of a chemical instrumentation training management model for Chemistry Medical Laboratory Technology lecturers is feasible to be applied in training, because it has practicality, usefulness, and effectiveness through validation of experts in their fields and individual, group and limited tests have been carried out with good criteria. In general, the chemical instrumentation training management model is better than the existing model, easier to understand, easier to implement, and more complete in its management elements, both planning, organizing, implementing, evaluating, monitoring, and following up after training.

To cite this article:

Maharani, E.T.W., Astuti, A.P., Yusrin. (2022). Implementation of Chemical Instrumentation Competency-Based Learning for Chemical Lecturers At Medical Laboratory Technology Program. *Thabiea : Journal of Natural Science Teaching*, 5(2), 193-203.

### Introduction

The commitment to improve human resources is not only applicable to counter the impact of globalization, but also to provide a new hope of excellent and dignified country. It is crucial that quality advancement is improved in order to uphold National Standard of Education. Government Regulations Number 19 Year 2005 about National Standard of

Education article 2 stated the 8 quality standards of education namely standard of content, process, competencies of the graduates, educator dan administration staff, facilities, management system, funding, and assessment as altered into Government Regulations Number 32 Year 2013 and amended by Government Regulations Number 13 Year 2015.

National Standard of Education stated that education process needs to uphold the minimum criteria of the education system. Therefore, educator (lecturer, in particular) with high capability and competences is the main key. According to Director General of Higher Education, Ministry of National Education (2003), the administration of education in tertiary institutions is considered of quality if it is capable of: (1) establishing and realizing a vision through the implementation of its mission; (2) fulfilling the needs of stakeholders, both social, work and professional needs.

According to Law Number 14 year 2005 Article 10 concerning Teachers and Lecturers, there are 4 (four) competency standards that a lecturer must have, namely pedagogical, personal, social, and professional competences. Article 1 point (2) clearly states that lecturers are professional educators and scientists with the task of transforming, developing, disseminating science, technology and art through education, research and community service. This article emphasizes that a lecturer is not only a professional educator but also a scientist. Furthermore, Article 45 states that lecturers are required to have academic qualifications, competencies, teaching certificates, be physically and mentally healthy and meet other qualifications required at the higher education unit where they are assigned and have the ability to achieve national goals. A lecturer is required to have high competence so that he can realize quality performance standards, which will lead to quality improvements that have an impact on the quality of graduates. Whether or not the quality of education is achieved is determined by the quality of the lecturers in each field of science they are engaged in, so lecturers are required to have high competence in order to realize quality performance standards.

Lecturer is one of the components in determining the quality of higher education. In each activity will be related to many things such as teaching, research and community service. However, well the rules and management are applied, it all depends on human resources as the main actors, as well as lecturers who teach in the health sector.

As lecturers who are teaching health personnel facing problems related to uneven distribution, inadequate quality of education, unequal composition of health workers; because it is still very dominated by medical personnel, and also low performance and productivity; it is necessary to review and restructure the education system for other health workers, both by the government and the private sector. The issue found in developing health personnel is the utilization of manpower with the unequal distribution of workers as the main problem. Career development of health workers is very necessary, including public sector personnel and private sector health workers.

Apart from the problem of health workers, Indonesia is also faced with the challenges of advances in science and technology which have resulted in a fundamental shift in the framework, education and strategy of activities to be implemented, increasing public awareness of healthy living and demanding health services that are more complete. In facing these challenges, it is necessary to develop a health service system and a system for procuring health personnel. In the health service system, there is a laboratory service subsystem that

requires support for the provision of personnel, so an educational institution that produces Health Analysts is needed. The objective of Medical Laboratory Technology education is to educate students to become Health Analysts who are able to: “1) conduct health laboratory examinations; 2) perform their profession according to professional standards and Medical Laboratory Technology code of ethics; 3) use and maintain and repair simple damage to laboratory equipment; (4) administering health laboratories; and 5) conduct health education according to their fields" (Health Ministry, 2010).

In Semarang, there are 4 (four) Universities having the major of Medical Laboratory Technology, they are: 1) Muhammadiyah University of Semarang; 2) 17 Agustus 1945; 3) State Health Polytechnics of Semarang; and 4) Theresiana Semarang” (Documents of Higher Education Board Coordinator Area VI Central Java, 2016). Subject of Instrumentation is given as one of the expertise classes related to performing analysis using instruments in the health laboratory. The focus of this course is all instrumentation used in health laboratory examinations according to the competence demands of a Medical Laboratory Technology, with the ultimate goal of providing skills for Medical Laboratory Technology in analyzing instrumentation. Types of equipment used: Glass tools, Analytical Balance, Turbidimeter, pH-Potentiometer, Polarimeter, Refracto-meter, Spectrophotometer, Electrophoresis, AAS (Atomic Absorption Spectrophotometer), Chromatography, Heating devices (incubator, waterbath, oven).

Based on the results of the survey conducted by the writer on Semarang Muhammadiyah University (2016), chemical instrumentation courses are taught by practitioners from the Provincial Health Laboratory Center and Medical Device Testing Center, Food and Drug Inspection Center, in which these institutions have complete and representative laboratory equipment. The result of the preliminary study showed that the professional competence of chemistry lecturers for chemical instrumentation is 85% not good and 15% very poor. This is due to the limitations of chemical instrumentation tools, especially the UV-Vis Spectrophotometer, Atomic Absorption Spectrophotometer (AAS), Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC). These instrumentation tools are needed in the learning process, but each educational institution is constrained by the high price of the equipment.

Based on a preliminary study conducted by the writer on 2016, it showed the need for chemical instrumentation training from the results of interviews with chemistry lecturers, including stating that chemistry lecturers need to develop competence in learning chemical instrumentation, because chemical equipment instruments continue to develop along with the progress of time, of course the principles of using basic instruments must still be studied. Other lecturers stated that chemistry lecturers really need to develop competence in learning chemical instrumentation because the world of work demands highly skilled students. To make students able to compete in getting the job, they must master these skills. There is surely a lack of training related to Chemistry and Science, so it is very urgent to provide the necessary training models. The following table presents data related to the lack of training for Chemistry lecturers in the Medical Laboratory Technology Study Program based on the survey results (2019), so that chemical instrumentation training is considered very important to be given.

**Table 1.** Frequency of Training done for Chemistry Lecturers of Medical Laboratory Technology Study Program

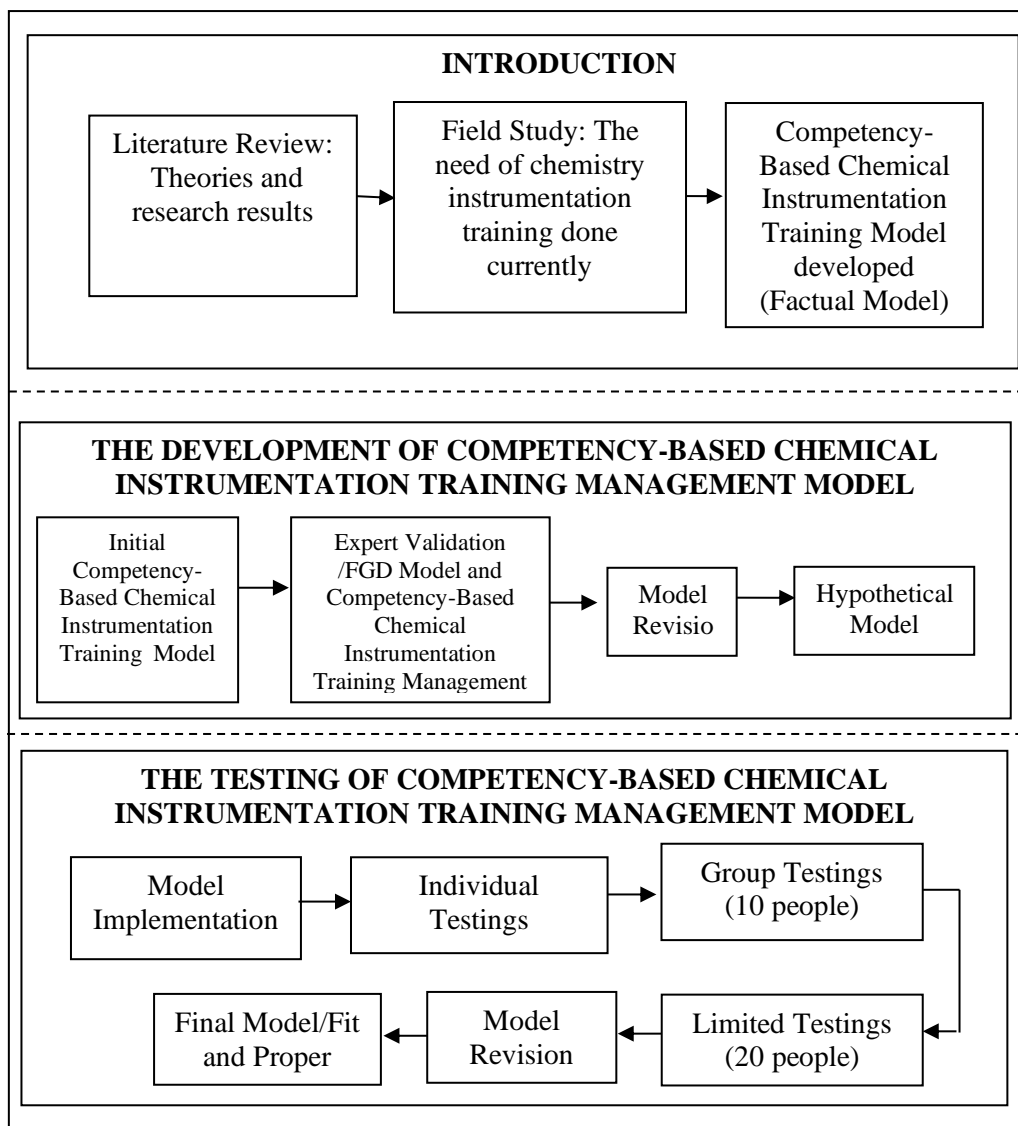
No	Institution	Joining Training		Total Number of Lecturers
		Ever	Never	
1	Medical Laboratory Technology Unimus	0	11	11
2	Medical Laboratory Technology 17 Agustus 1945 Semarang	0	2	2
3	Medical Laboratory Technology Poltekkes Kemenkes Semarang	1	4	5
4	Medical Laboratory Technology Theresiana Semarang	0	2	2

Interview results from respondents, 2019

Table 1 describes that most of the lecturers have not undergone the training of Chemical Instrumentation, therefore the formulated research questions are 1) what is the currently applied factual model of Chemical Instrumentation training management for chemistry lecturers of Medical Laboratory Technology?; 2) what is the hypothetical model for developing a management model for competency-based chemical instrumentation training for chemistry lecturers of Medical Laboratory Technology?; and 3) what is the final management model of Competency-Based Chemical Instrumentation training for chemistry lecturers of Medical Laboratory Technology?.

## Method

The research design model is using Research and Development or R&D method, developed into 3 (three) main components namely: developmental model, developmental procedure, and product testing (Sugiyono, 2010). The model developed is in the form of a conceptual model that is analytical, presenting product components, analyzing components in detail and showing the relationship between the developed components. The study was conducted to determine the training of Chemistry lecturers that has been carried out at universities in Semarang which have a Medical Laboratory Technology Study Program. The research and development design carried out in this study can be presented as in the following chart.



**Figure 1.** Chart of Research and Development of Competency-Based Chemical Instrumentation Training Management Model for Chemistry Lecturers of Medical Laboratory Technology Study Program

Based on the research data, analysis can be carried out using quantitative descriptive techniques to determine: 1) the training management model that has been carried out so far; 2) the feasibility and applicability of the model; 3) feasibility and applicability of the material; and 4) feasibility and applicability of manuals and guides. The statistical analysis technique used is quantitative descriptive analysis obtained from the percentage of answers to a Likert scale questionnaire that has been modified to the product in the form of a numerical answer score.

## Results and Discussion

### 1. Current Model of Chemical Instrumentation Training Management

The management model of chemical instrumentation training for Chemistry lecturers of Medical Laboratory Technology Study Program is seen from the competencies that must be mastered by the lecturers, including professional, pedagogical, personality, and social competences. Based on the research results, it is known that the lowest score is professional competence with unsatisfactory criteria of 17 or 85.00%, it can be argued that the professional competence of Medical Laboratory Technology Study Program Chemistry lecturers needs to be improved by giving training, while pedagogic, personality, and social competences do not need improvement such as to be given training because they have been obtained various criteria, namely very good and good.

Referring to the results of the distribution of instruments as a survey before data collection in the field begins, it can be argued that in principle Medical Laboratory Technology Study Program Chemistry lecturers need chemical instrumentation training, because the implementation of chemical instrumentation training that has been carried out and followed is considered less effective in increasing the competence of lecturers, especially on professional competence. This is supported by the conclusion of the interview results that there is a need to increase the professional competence of lecturers, especially learning in the laboratory in order to improve the quality of education services which leads to improving the quality of graduates, namely producing competent and professional Medical Laboratory Technology graduates.

The importance of chemical instrumentation material for the Chemistry lecturer of Medical Laboratory Technology in accordance with Chen's opinion (2011) which explains that identifying and formulating problems through identifying needs, making decisions, investigating and formulating achievement criteria has a positive impact towards a better process. Therefore, the development of a chemical instrumentation training management model for Chemistry lecturer of Medical Laboratory Technology provides strengthening in improving professional competence. The importance of this chemical instrumentation by looking at and reading the situation in the future that in the era of globalization, the development of human resource (HR) skills is the main topic that is often emphasized as a need in cooperation between employment conditions and educational institutions. More firmly Robert-Zhang (2012) stated that skills proficiency requirements are needed by the public, so higher education must manage soft skills especially in the global era. Hamalik (2007) also provides an opinion based on the needs assessment, the type and amount of training required can be determined. Ali Shah (2001) conducted a study with the results of the performance of teachers who graduated from training who worked in Islamic State Middle Schools in Islamabad relatively better than teachers who did not attend training. Supriyono (2008) indicated that teacher training carried out periodically through reflection and cross-simulation will be able to increase competence in Integrated Science subjects. Hamid (2012) also explained that the identification of the needs of the world of work which is followed up by integrating the topic approach according to the needs of the world of work, then the course of activities in the organization will fail.

Descriptions of several theories and descriptions of the results of previous research describe that a clear and systematic organization of chemical instrumentation training will have a positive impact on total management quality, institutional effectiveness, and innovation synergy towards the goals to be achieved. Thus, the identification of needs becomes the essence of a development activity, so that chemical instrumentation training is in accordance with the needs of lecturers to support learning in the laboratory, in addition to technical abilities, knowledge, and specific skills that become the basis for health professional education institutions. Smith's research results (2013) explained emotional competence as a self-regulating skill and very important to produce excellent service quality. Some of the basics are the importance of developing a product that is preceded by the identification of the

needs of the field so that the development and subsequent results can provide effectiveness, as is done in this research and development.

## 2. Development of the Competency-Based Chemical Instrumentation Training Management Model for Chemistry Lecturers

The development of the Competency-Based Chemical Instrumentation training management model that was developed was compiled through an expert validation process from academics and chemical practitioners. The results of the assessment obtained that the overall mean of the development of a chemical instrumentation training management model for the assessment of experts / academics and practitioners was 3.60 with very satisfactory criteria, as shown in Table 2.

**Table 2.** Model Development Assessment by Academic Scholars and Practitioners

No	Assessment Indicator	Average	Rating
1	Structure of Training Model	3,80	Very Satisfactory
2	Benefit of Training Model	3,70	Very Satisfactory
3	Feasibility of Training Model	3,80	Very Satisfactory
4	Implementation of Training Model	3,10	Satisfactory
<b>Average</b>		<b>3,60</b>	<b>Very Satisfactory</b>

These results indicate that the development of a competency-based chemical instrumentation training management model for Chemistry lecturer of Medical Laboratory Technology can be used and can be applied in chemical instrumentation training.

The chemical instrumentation training management model developed adopts Terry's (1997) management model with 4 (four) management functions and resource utilization according to the chemical instrumentation training needs analysis. The management function is developed from planning, organizing, implementing, and evaluating. Based on the findings from the management function of conducting chemical instrumentation training, which has been carried out in several universities that have a Medical Laboratory Technology Study Program, there has not been an evaluation of the training program and no follow-up has been carried out after the training. The development of the Competency-Based Chemical Instrumentation training management model optimizes findings that have not been carried out in training delivery. Model development by evaluating training programs and post-training follow-up, as well as utilizing resources from instructors, chemistry lecturers, laboratory assistants, study materials / chemical instrumentation materials, training sarpras, and methods, is proven to increase the professional competence of Chemistry lecturer of Medical Laboratory Technology.

The results of the development above are in line with the findings of Haryono (2017) which show that training programs are an important effort in providing knowledge and insights about various learning innovations, both conceptual and practical in order to increase the professionalism of teachers (and lecturers). The results of Supriyono's (2008) research also show that periodic training for teachers through cross-reflection and simulation can improve teacher competence in Integrated Science subjects. The importance of this training management was highlighted by Maryati & Widodo (2012) who revealed that SMP / MTs science teachers in the Special Region of Jogjakarta did not understand and had not implemented Integrated Science learning and had never even had Integrated Science training.

In particular, Widodo's research results (2015) state that in general teachers and supervisors benefit from the PICOLA (Participatory Integrative Collaborative) training, namely the flexibility of

training activities including: teacher interaction with training materials / materials, teacher interaction with supervisors, interaction among teachers to implement full participation with participants. It is further illustrated that the training participants in the implementation can collaborate integratively with the facilitator / instructor.

Based on studies that are associated with some of the results of previous researchers with the results of research that researchers have developed, it means that the results of research conducted by researchers provide an increase in the professional competence of lecturers, because the Competency-Based Chemical Instrumentation training management model for Chemistry lecturers of Medical Laboratory Technology is easy to implement by educational institutions, especially Universities that have the Medical Laboratory Technology Study Program and also for training institutions.

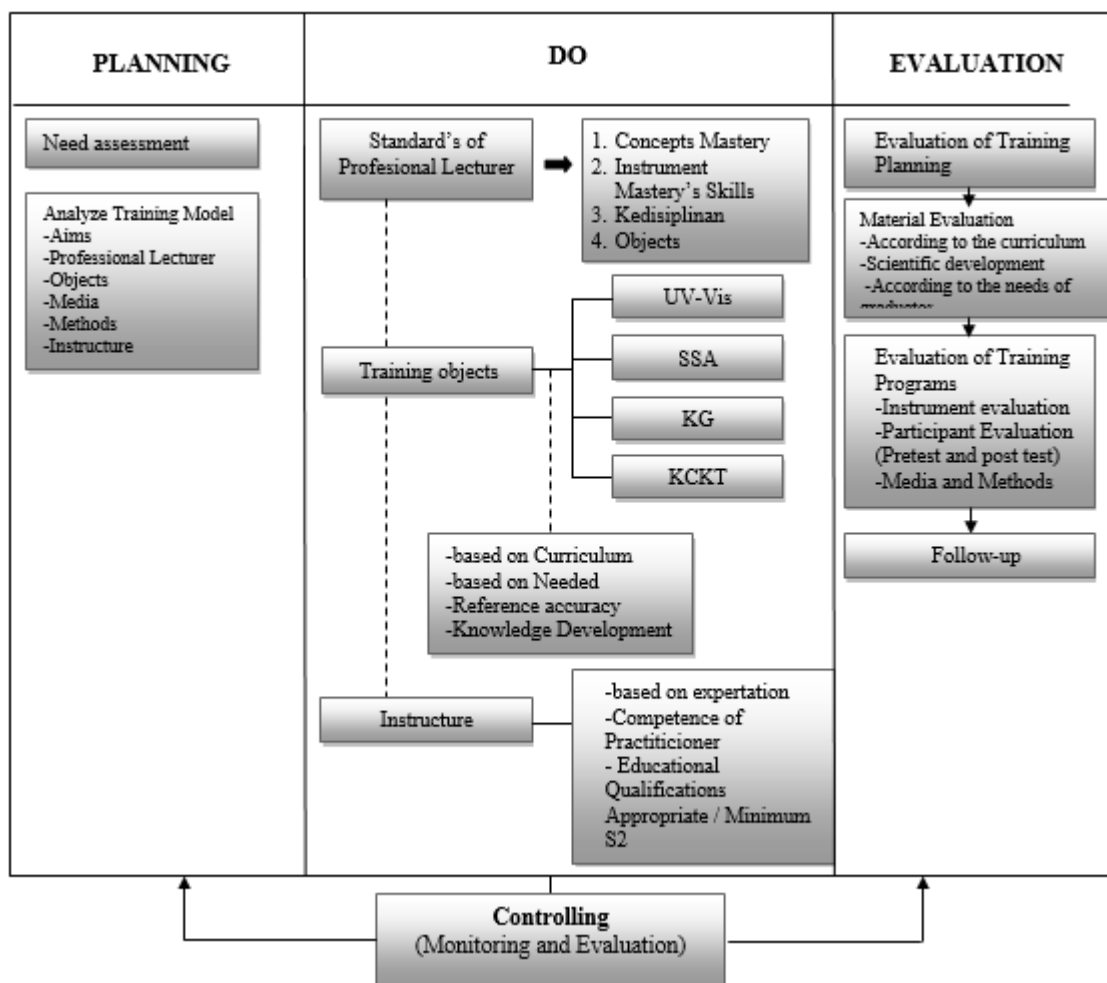
### **3. The Feasibility of the Competency-Based Chemical Instrumentation Training Management Model for Chemistry Lecturers**

This explanation of the feasibility of the Competency-Based Chemical Instrumentation training management model for Chemistry lecturers of Medical Laboratory Technology is the final model found. The determination as the final model is based on trial findings, namely individual, group and limited trials. The display of the entire presentation table of research data illustrates the increase in the effectiveness of the results so that the product is feasible to be applied in the field as a final model, both for Chemistry lecturers of Medical Laboratory Technology and chemical instrumentation training institutions. The resulting product is called a feasible model to be applied and is also called the final model, because the Competency-Based Chemical Instrumentation training management model for Chemistry lecturers of Medical Laboratory Technology has several advantages.

- a) The Competency-Based Chemical Instrumentation training management model for Chemistry lecturers of Medical Laboratory Technology as a result of the development is based on an analysis of the needs of participants by implementing management functions, including: planning, organizing, implementing, evaluating, monitoring as well as post-training follow-up to determine the professional ability of learning chemical instrumentation for graduate or post training.
- b) The Competency-Based Chemical Instrumentation training management model and the training package resulting from the development are easier for the training participants to understand and easier for any educational institution that has a Medical Laboratory Technology Study Program as a training provider.
- c) The Competency-Based Chemical Instrumentation training management model for Chemistry lecturers of Medical Laboratory Technology as a result of this development has effectiveness values: 1) proven to increase the professional competence of chemical instrumentation in training participants before training (pre-test) score <54 = 35%; score 55-69 = 45%; score 70-89 = 20%, and post-training score 70-89 = 35%; score 90-100 = 65%. The results of the assessment for the management model category of the Competency-Based Chemical Instrumentation training for Chemistry lecturers of Medical Laboratory Technology for training participants were very good.
- d) Implementation of the Competency-Based Chemical Instrumentation training management model for Chemistry lecturers of Medical Laboratory Technology to provide real experience and apply other courses relevant to instrumentation learning for training participants.

The differences in the results of the development of the Competency-Based Chemical Instrumentation training management model are the stages of model application in chemical instrumentation training.





**Figure 2.** Chemical Instrumentation Training Management Final Model Competency-Based for Health Analyst Chemistry Lecturers

The final result of model development is the most suitable model to be applied for training in chemical instrumentation for Chemistry lecturers of Medical Laboratory Technology. The post-test results show an increase compared to the pre-test results, it shows that the development of a chemical instrumentation training management model is appropriate and effective in improving the professional abilities of chemistry lecturers. This is in line with the results of research by Osunde & Omoruyi (2004) that the training program is quite effective in improving the skills and knowledge of participants. The results of Moeini's (2008) research show that training for teachers can improve professionalism at work, according to Harrison's (2008) research results illustrating that after participating in training, teachers are able to demonstrate teaching achievement by developing sustainable professionals in programs that lead to practice.

## Conclusion

The training management model for Chemistry lecturers of Medical Laboratory Technology that has been implemented has not been able to accommodate the aspirations of chemistry lecturers related to chemical instrumentation material. This is due to: 1) in the planning of training, only institutional needs are carried out, training modules are not available, and infrastructure is inadequate; and the appointment of instructors is not appropriate; 2) organizing the training, in determining the material not according to competency needs, instructors from practitioners in their fields but lacking knowledge of the concept of the material, determining the allocation of participants based on the available budget; 3) implementation: carried out at the appointed institution, the material is determined by the institution concerned, there is no training package book; and 4) evaluation: not done, pre-test and post-test rarely performed, and no follow-up after training.

The design of the Competency-Based Chemical Instrumentation training management model development consists of planning, organizing, implementing, evaluating, monitoring, and following up after training, so it is better than the implementation of training so far. 1) training planning is based on the needs of the lecturers; 2) organizing a small committee; 3) implementation is easier to run because there is already a training package (manual and training manual, as well as chemical instrumentation teaching materials), post-training follow-up provision; and 4) evaluation is carried out as a whole in its implementation from teaching materials, programs, procedures, instructors, facilities and infrastructure.

The design of the Competency-Based Chemical Instrumentation training management model development for Chemistry lecturers of Medical Laboratory Technology is feasible to apply. This means that if this model is applied to meet the specified requirements such as curriculum, teaching materials (hand out), instructors, this training will be able to increase the professionalism of lecturers in the use of chemical instrumentation.

## Suggestion

For lecturers; the implication of the chemical instrumentation training management model focuses on management development on the task objectives and roles of lecturers of Medical Laboratory Technology, so that the optimal involvement of lecturers through designated management activities becomes the basis for developing chemical instrumentation training in planning, organizing, implementing, and evaluating activities, so that this model can be used as an alternative model for the implementation of training by other institutions.

For the government; In policy making, it is necessary to make efforts to increase the ability of lecturers through training, one of which is by using the Competency-Based Chemical Instrumentation training model for Chemistry lecturers of Medical Laboratory Technology. The phenomena of problems and needs faced by lecturers in improving their professions related to the preparation of teaching materials, actually through training can be overcome, but cannot be resolved optimally. Therefore, chemistry lecturers hope that there will be guidance or training from other parties, apart from universities or fellow chemistry lecturers to be able to solve the problem completely.

## References

- Ali Shah, M. S. (2001). "In Service Training of Secondary Level Teachers: a Follow up of Teachers' Performance in Comparative Perspective". *Journal of Education and Practice*. 2222-1735.2 (11&12): 40-49.
- Chen, Ming Nan. (2011). Next-generation Quality Promotion Programmes in Taiwan. *Total Quality Management*. 219-225.
- Hamid, Siti Abd Rafiah. Hassan, Sharifah Syed and Hisam Nik Ismail. (2012) Teaching Quality and Performance Among Experienced Teachers in Malaysia, *Australian Journal of Teaching Education*, Volume 37.
- Hamalik, O. (2007). Manpower Training Management Integrated Approach to Human Resource Development. Fourth Publication. Jakarta: Bumi Aksara.
- Harrison, Christine. (2008). "Evidence-Based Professional Development of Science Teachers in Two Countries". *International Journal of Science Education*. 1464-5289, 30 (5): 577-591.
- Haryono, Stanislaus, Sugiyarta., Budiyo, Widhanarto,G.P. (2017). Improving Teacher Professionalism through Learning Innovation Training: Pilot Program for Teachers in Semarang Regency. *Journal of Lembaran Ilmu Kependidikan*. Volume 46. Number 2. September 2017. Page 75-80.
- Maryati., Hastuti, W. P, dan Widodo, Eko. (2012). Level of Understanding and Difficulties in Implementing Integrated Science Learning for Junior High School in Yogyakarta Special Region. UNY. <http://eprints.uny.ac.id/462/>
- Moeini, H. (2008). "Identifying Needs: A Missing Part in Teacher Training Programs". *International Journal of media, technology and lifelong learning*. 4 (1): 1-12.
- Osunde & Omoruyi. (2004). "An Evaluation of the National Teachers Institute's Manpower Training Program for Teaching Personnel in Mid-western Nigeria Faculty of Education, University of Benin, Nigeri a. *International Education journal* .5 (3): 405-409.
- Robert. Zhang. (2012). Peer Assessment of Soft Skills and Hard Skills. George Southern University, Statesboro. *Journal of Information Technology Education: Research* Volume 11: 298-310.
- Smith, K.,F. (2013). Clinical Evaluation: An essential Tool in Emotional Competency Development. *The International Journal of Learning*. Volume 15 (7) : 297-306.
- Sugiyono. (2010). Educational Research Methods (Quantitative Approaches, Qualitative and R&D). Bandung: Alfabeta.
- Supriyono. (2008). Study of the Implementation of Integrated Science Learning in East Java Junior High School. National Seminar on New Trend of Physics and Education. Physics major of UM. <http://dc934shared.com/doc/OFMRrCA/preview.html>.
- Widodo,K.S., Widodo, J., Masrukan. (2015). Development of a Collaborative Integrative Participatory Education and Training Model to Improve the Professional Competence of High School Physics Teachers. *Journal of Educational Management EM* 4 (2). 116-124.