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Development of Web-based Application for Teacher Candidate Competence Instruments: Preparing Professional Teachers in the IR 4.0 Era

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Abstract: This research aimed to develop a web-based application for teacher candidate competence instruments to prepare professional teachers in the Industrial Revolution 4.0 (IR 4.0) era. Teacher candidate competencies consist of pedagogical, professional, social, and personality competencies. This is a research and development with 8 stages, involving the development of instrument grids/ construct, focus group discussions, instrument item development, instrument validation, manual instrument testing, application development, application assessment by experts, application trial, and final revision of the application. The initial focus group discussions involved 9 experts, while the instrument validation involved 55 experts consisting of 21 experts for pedagogical and professional competencies, 7 experts for social competencies, 7 experts for the personality competencies, and 4 media experts. The trial involved a total of 167 Mathematics, Indonesian, and English student teacher candidates. Expert validation was analyzed using the Aiken formula, application effectiveness and readability were described based on expert judgment, and discrimination tests on the results of social and personality competence tests between the study programs used the Multivariate Analysis of Variants. The results showed that there were no differences in social and personality competencies between Mathematics, Indonesian, and English prospective teachers. The developed instruments for pedagogical, professional, personality, and social competencies were deemed valid. The application has met the usability aspect and is scored well by experts with an average assessment rating of 78. These results suggest that the application can be used by the government as a solution to assess teacher candidate competencies in the IR 4.0 era.

Keywords: *Instrument application IR 4.0, pedagogy, professional, social, personality.*


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Introduction

The quality of education plays an important role in the life within the community. Through education, humankind finds a breakthrough to manage life. However, to this day, the quality of education in Indonesia remains low. The findings in the Trend in International Mathematics and Science Study (TIMSS) revealed low levels of student abilities (Stephens et al., 2016). The challenge faced by Indonesia is the Industrial Revolution 4.0 Era (IR 4.0) As said by Popkera et al (2010) in which all types of machinery are connected and there is a high dependence on the cyber-physical system which will radically change how humans live, work, and communicate. Work that was originally done manually by relying on human labor alone has been replaced by machinery and information technology. This change has an impact on education where the quality of learning carried out by teachers at school is a key factor.

At present, the quality of education in Indonesia still needs improvement. The results of the 2015 PISA (International for Student Assessment Program) show that Indonesia ranks 63 out of 79 countries studied (Organization for Economic Cooperation and Development [OECD], 2016). A study by Kusumawadani (2017) on

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the impact of teacher certification in Indonesia 10 years after certification found that there was no increase in performance and motivation, suggesting that certification allowances almost do not influence their performance. Therefore, it is necessary to re-examine the system of evaluation and the graduation selection associated with the teacher certification so that the certification program funded by the government can achieve the expected goals. It can be concluded that there will be great problems if there is no specific selection for teachers which determines teacher competences. Leonard (2016) research results show that teachers in Indonesia do not yet have adequate competence, especially in terms of designing learning and research so that careful solutions are needed to overcome teacher competency issues. Besides, according to the results of the Batubara (2018) study, the competence of teacher ICT in Indonesia is in the sufficient category and needs to be improved, especially teachers who are in the outermost regions. Some aspects of teacher ICT competence of concern are mastery of ICT devices, understanding of the design of developing instructional materials using ICT, and methods of using ICT devices in the classroom. ICT is an important part of the era of IR 4.0 and the 21st century which entered the digital literacy aspect.

Jones (2018) explains that education in the 21st century prioritizes individual and social development, as well as adequate skills equipped with critical thinking skills, creative abilities, adaptability, and entrepreneurship. These conditions raise challenges to improve the ability of professional teachers who must have good personalities, master teaching materials, be skilled in using various media and teaching methods, and be able to communicate well. Therefore, the Institute of Education and Education Personnel (Lembaga Pendidikan Tenaga Kependidikan [LPTK]) must generate graduates who can become good teachers by not only mastering the four competencies of personality, social, pedagogical, and professional competences, in addition to the specific competencies required in the IR 4.0 era, but also competing with teachers from other neighboring Association of Southeast Asian Nations (ASEAN) countries and implementing creative, innovative, and dignified learning. To incite breakthroughs in improving the quality of LPTK graduates, there needs to be a development of an evaluation model for teacher candidate competences in the IR 4.0 era. This evaluation model must be able to depict the competence levels of prospective teachers graduating from LPTK as well as the sub-competencies that have not been mastered concerning the teacher competencies needed in the IR 4.0 era.

Teacher competencies are a set of knowledge, skills, and behavior that must be possessed, internalized, and mastered by the teacher in carrying out his professional duties (Musfah, 2012). According to Law No. 14 of 2005 on Teachers and Lecturers, teacher competencies must include pedagogical competences, professional competences, personal competences, and social competences obtained through professional education. Teacher competences must be dynamic and develop according to the development of science and technology, especially in the era of the Industrial Revolution (IR) 4.0.

In detail, Popkova et al. (2018) explained that the industrial revolution 4.0 refers to a trend related to the "digitalization" of the economy and society, including the development of smart services, smart data, cloud technology, digital networks, digital science, digital education, and the digital environment for life. Meanwhile according to a study by Ghorbani et al. (2018) "the findings obtained from two qualitative and quantitative sections of the present study showed that the teachers of the 21st century should educate students in a way that they could learn how to be in today." A similar notion was also conveyed by Van Hong et al. (2018) who revealed that 21st-century teachers are required to have at least three competencies, one of which is the ability to apply technology in learning. This opinion was strengthened by Aoun (2017) who stated that there are three new literacies needed in the IR 4.0 era, namely technological literacy, data literacy, and human literacy.

The four competencies set out in Law No. 14 of 2005 on Teachers and Lecturers are integrated and supported by a mastery of technology so that each competence can be applied by maximizing the media and technology based on the demands of the industrial revolution era 4.0. Another thing that needs to be considered by professional teachers is the perception of the development of students' knowledge. This is consistent with the results of research conducted by Gilroy (2018) which found that professional teachers should not assume that the development of learners' knowledge from year to year remains the same because the assumptions are only based on previous data without directly observing the development of students at that time in the field obtained through the assessment process.

Assessment as an integrative part of the curriculum and learning process is the most important part to provide information on the fulfillment of graduate learning outcomes and evaluation of program achievements and institutional success. In addition to the four main competences, teacher candidates must also IR 4.0 top ten skills delivered in the World Economic Forum, i.e. complex problem solving, critical thinking, creativity, people management, coordinating with others, emotional intelligence, judgment and decision making, service orientation, negotiation, and cognitive flexibility (Gleason, 2018). Therefore, the scope of prospective teacher competences in the IR 4.0 era not only refers to those stated in Law No. 14 of 2005 on Teachers and Lecturers but must also be added with specific competences, at least the top ten skills that will be needed in the order of priority by employers by 2020 and three new types of literacy. These concepts and theories are used to develop the instruments to measure teacher competences in the IR 4.0 era.

The measurement results are used as a basis for assessing and evaluating. Evaluation is a systematic activity to identify, clarify, and apply criteria to determine the success of a program (Fitzpatrick et al., 2011). Meanwhile, Mertens (2014) explained that evaluation is a systematic and objective effort to assess the development and achievement of the goals of a program. This is under a study of Mardapi (2018) who revealed that each evaluation requires information on the results of the assessment and measurement data. Measurements can be made through exams, to find out the results of students and the teaching success of teachers. Stiggins (2011) explain that assessment is the process of gathering information about student learning to improve learning. Based on these references, it can be concluded that the notion of evaluation in the field of education is a process of assessing the achievement of educational goals and providing input for the improvement of educational programs which includes the process of collecting, processing, and analyzing data that are carried out systematically and scientifically to see to what extent the program has achieved the goals based on predetermined criteria. The developed evaluation model for teacher candidate competences has two main advantages based on its usefulness, namely that it is useful to select professional teacher candidates as well as to serve as an evaluation material for mapping the quality of teacher training institutions which produce prospective teachers following Law No. 14 of 2005 on Teachers and Lecturers, in addition to the mastery of knowledge in the Industrial Age 4.0.

Muharram et al. (2020) successfully developed an application for the Prospective Teacher Student Recruitment System. This research does not accommodate students who have registered as it is more on prospective students. Therefore, the model developed in this study will improve the previous system. Several studies developed an assessment application to be used by teachers (Adnan et al., 2019; Idrissi et al., 2020; Jusuf et al., 2019). However, this is not a website-based application, so that it is limited. It does not accommodate four competencies of teacher candidates. Thus, one of the advantages of the application developed in this study is that it accommodates those four competencies, and it is website-based.

Research conducted by Brajic et al. (2020) and Saputro et al. (2020) are more focused on professional competence and self-efficacy in terms of attitude, so the aspects of social and personality competencies are not directly measured. Moreover, Tobajas et al. (2019) developed a comprehensive rubric assessment application. The rubric was developed to evaluate the main assignments for the course, namely Personal Work, Written Reports, and Oral Presentations. The developed application is comprehensive, but specifically, it does not include both social and personality aspects. The previous research regarding the development of teacher competency instruments was conducted by Panggabean and Himawan (2016) which produced a valid and reliable Teacher Competence Questionnaire. The study has been good, but it is still limited to questionnaires (does not use tests to measure cognitive aspects) and did not sufficiently accommodate data literacy, digital literacy, and humanity literacy as demanded in the industrial revolution era. 4.0. Besides, this research was still common for all courses. This is what inspired the researcher to further explore the topic. Furthermore, this study has the advantage of developing instruments that contain four competencies based on knowledge content (each courses employs different instruments test and questionnaires) and equipped with three literacy and top ten skills reflecting the era of Industrial Revolution 4.0.

The objective of this study is to develop a web-based evaluation model for prospective teachers' competences in the IR 4.0 era that is accurate and reliable. It is expected that the developed model can provide the competence profile of each prospective teacher in a quick, accurate, and reliable manner, as well as depict their weaknesses regarding their competence in the IR 4.0 era. Furthermore, the results of the competence assessment of each teacher candidate are used to evaluate and improve the teacher preparation program.

Methodology

Research Type

This research is a study on the development of a teacher candidate competence instrument application in the Industrial Revolution (IR) 4.0 era. The instruments consist of four main competencies for teacher candidates involving pedagogical, professional, social, personality competences, as well as other competencies needed in the IR 4.0 era.

Development Procedure

The development of competence instrument application for teacher candidates in the IR 4.0 era was done through 8 stages. The first stage was the development of instrument grids/ construct, which did not only cover the four main competencies (pedagogical, professional, social, and personality) but also had the addition of the top ten skills or competencies needed in the IR 4.0 era, as well as the three types of literacy, namely data, digital, and humanity literacies. The next stages were the focus group discussions, which were aimed to validate the new grids that had never been developed before, and the instrument item development, where items were developed based on the grids approved by the experts. The fourth stage was the instrument validation, which was done prior to trial in order to learn the item conformity toward the indicators, as well as testing whether the developed instruments work as designed by the researchers. The next stage was the manual instrument trial, which was important before the instruments were incorporated in the web-based application system. After that, the application development was done once the best

instruments and models had been obtained based on the experts' suggestions. In the following stage, the application was assessed by experts after it was fully developed with all instruments incorporated in the application system. The assessment was done in two stages, namely on the initial application model and after the application was revised. The assessment was done on content, interface, navigation, configuration, and security. Finally, the application trial was conducted from each of the student's residence by following the terms and schedule set by the researchers. The result of the trial was then used as a basis to deliver the last stage of the development procedure, namely the final revision.

The instruments for IT experts are used to obtain data on the product's quality based on its conformity with the web-based software quality standards. The instruments used are developed based on Pressman's theory on web application testing (Pressman, 2005). The aspects assessed by the media experts are presented in Table 1.

Table 1. Summary of assessment instrument grids for media experts

No.	Assessment Component	Indicator
1	Content	Language use
		Information accuracy and thoroughness
		Presentation of content structure
2	Interface	Usability of the menu and buttons
		Navigation placement
		Image and text readability
		Aesthetics and usability
3	Navigation	Resolution size
		The accuracy of the navigation link
		Ease of finding the content object
		The accuracy of the link name and link destination in the navigation system
		The ability to return to specific pages
4	Configuration	Configuration with database software
		Web application script
		Compatibility with every device that can access a web application
5	Security	The ability to verify the user identity which can access web applications
		The ability to encrypt certain data such as user passwords that do not appear on the screen
		The ability to filter users that allows access to certain features or pages

Participants

The FGD to agree on the instrument blueprint involved 9 experts namely 3 measurement experts, 1 pedagogical expert, 3 professionals (Indonesian language, English Language and Mathematics), and 1 social expert, and 1 personality psychology expert. The instrument validation involved more experts, 35 people consisting of 21 experts for pedagogical and professional competences (7 pedagogical experts and Indonesian Language professional, 7 pedagogical experts and English Language professional, and 7 pedagogical experts and mathematics professionals), 7 social science experts, and 7 experts in the field of personality psychology. The application evaluation involved 4 media experts. The tryout involved 107 students for the instrument and application tryout.

Data Analysis Technique

The data analysis of the FGD results was carried out using a quantitative and qualitative descriptive analysis. Each competence was analyzed separately and compared with the minimum criteria. The analysis of the expert validation results used the Aiken formula and factor analysis for social competence, and the personality competence used the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). The different tests on the results of social and personality competence tests between the study programs employed the Multivariate Analysis of Variants (MANOVA). Prior to being tested using MANOVA, the homogeneity of variances was first tested using *Levene* statistic and normality test using the one-sample *Kolmogorov Smirnov* tests. The analysis result shows that all variances are the same or homogeneous. In addition, the analysis result shows that the data is normally distributed with P value > 0.05.

Findings / Results

Development Results

The development results focus on 4 stages of 8 stages that will be implemented namely; involving the development of instrument grids/construct, focus group discussions, instrument item development, instrument validation, manual instrument testing. The competence evaluation model for prospective teachers in the IR 4.0 era consists of four

competencies: Pedagogical Competence, Professional Competence, Personality Competence, and Social Competence. The four competencies are strengthened by the Top ten skills and three literacies as the characteristic of the IR 4.0. The top ten skills are Complex problem solving, Critical thinking, Creativity, People Management, Coordinating with others, Emotional intelligence, Judgment and decision making, Service Orientation, Negotiation, and Cognitive flexibility (Gleason, 2018), whereas, the three literacies are digital literacy, data literacy, and humanity literacy. The agreement result from the Focus Group Discussion involving all researchers and material experts succeeded in developing the blueprint with the format in

Table 2. Blueprint Format-Example of Mathematics Pedagogical Competence Blueprint

No	Aspect/dimension	Sub Aspect	Indicator	IR 4.0 Component	IR 4.0 Literacy	Item Number
1	Mastering students' characteristics from physical, moral, spiritual, social, cultural, emotional, and intellectual aspects	Identifying students' initial learning provisions in the subjects being taught.	Identifying the emotional intelligence needed to master the characteristics of students as an initial provision for teaching mathematics	Top ten 6. Emotional intelligence	Humanity Literacy	1

The blueprint format in Table 2 already illustrates that the instrument to be developed is not only computer-based. The instrument also describes the components of IR 4.0. The results obtained were then validated and analyzed by all teams and experts based on their field. The instrument which has been developed consists of pedagogical competency, professional competency, social competency, and personal competency instruments to measure prospective Teachers of Bahasa Indonesia, English, and Mathematics. The number of items in each of the instruments is presented in Table 3.

Table 3. Number of items in each competency for prospective Bahasa Indonesia, English and Mathematics teachers

Subjects and Competencies	Total Items			
	Pedagogical Competency	Professionalism Competency	Pedagogical Competency	Personal Competency
Bahasa Indonesia	20 Items	40 items	30	30
English	20 Items	40 items		
Math	20 Items	40 items		
Total	60 Items	120 items	30 Items	30 Items

Pedagogical and professional competencies for prospective teachers of mathematics, Bahasa Indonesia, and English are different but for social and personal competencies using the same instruments. In detail, it will be exemplified for the instruments of prospective math teachers. The pedagogical competence instrument consists of nine aspects, namely 1) mastering students' characteristics from physical, moral, spiritual, social, cultural, emotional, and intellectual aspects, 2) mastering learning theories and educating learning principles, 3) developing a curriculum related to the subjects being taught, 4) organizing educational learning, 5) utilizing information and communication technology for learning purposes, 6) facilitating the development of potential learners to actualize their various potentials, 7) communicating effectively, empathically, and politely with students, 8) carrying out assessment and evaluation of learning processes and results, and 9) applying the results of assessment and evaluation for learning. The nine aspects are translated into sub-aspects that are combined with the Top ten skills and three literacies as the characteristics of the IR 4.0 Era. The top ten skills referred to are Complex problem solving, Critical thinking, Creativity, People Management, Coordinating with others, Emotional intelligence, Judgment and decision making, Service Orientation, Negotiation, and Cognitive flexibility. The three literacies are digital literacy, data literacy, and humanity literacy. Based on the results of the expert validation and analysis using the Aiken formula, the pedagogical competence instruments for all subjects are categorized valid with an Aiken index above 0.7. This is presented in Table 4.

Table 4. Validity Analysis Results for Every Aspect

No	Aspect	CVI	Criteria
1	Mastering students' characteristics from physical, moral, spiritual, social, cultural, emotional, and intellectual aspects	0.88	Valid
2	Mastering learning theory and learning educational principles	0.93	Valid
3	Developing a curriculum related to the subjects being taught	0.90	Valid
4	Organizing educational learning	0.75	Valid
5	Utilizing information and communication technology for learning purposes	0.77	Valid
6	Facilitating the development of potential learners to actualize their various potentials	0.93	Valid
7	Communicating effectively, empathically, and politely with students	0.89	Valid
8	Carrying out assessment and evaluation of process and learning outcomes	0.89	Valid
9	Applying the results of assessment and evaluation for learning.	0.84	Valid
Average CVI		0.86	Valid

The professional competence instrument of Mathematics consists of six aspects, namely 1) Mastering the material, structure, concepts, and scientific mindset that supports the subjects taught, 2) Mastering competence standards and basic competences, 3) Developing learning materials taught creatively, 4) Developing professionalism sustainably by taking reflective action, 5) Utilizing information and communication technology for self-development, and 6) being able to do an evaluation. The six aspects are translated into sub-aspects that are combined with the Top ten skills and three literacies as the characteristic of the IR 4.0 era. Based on the results of expert validation and analysis using the Aiken formula, the professional competence instruments for all subjects are included in the valid category with an Aiken index of above 0.7.

The instrument was developed to measure the personality competences of prospective teachers in the IR 4.0 era. This instrument was developed from five indicators, namely: (1) acting following legal, social, religious norms and Indonesia's national culture, (2) presenting themselves as an honest and noble person, and a role model for students and community; (3) presenting themselves as a stable, mature, wise, and authoritative person; (4) showing work ethic, high responsibility, pride as a teacher, and self-confidence; and (5) upholding the code of ethics of teaching profession.

Initially, the instrument to measure the personality competences of prospective teachers in the IR 4.0 era consisted of 34 items. The items were reviewed and assessed by 7 experts and then calculated using the Aiken formula. According to Aiken (1985), if the expert is 7, there are 5 options for each item, and the minimum CVI value is 0.75. The results of the analysis with the Aiken formula show that Item Numbers 22 and 24 were rejected because the value of CVI was only 0.38 and 0.5 so that there were still 32 items. The results of the content validity of each aspect/factor are presented in Table 5.

Table 5. The results of the content validity of the personality competence instrument

No	Aspect	CVI	Criteria
1	Acting by religious, legal, and social norms and Indonesia's national culture	0.88	Valid
2	Presenting themselves as an honest and noble person, and a role model for students and the community	0.88	Valid
3	Presenting themselves as a person who is steady, stable, mature, wise, and authoritative	0.81	Valid
4	Demonstrating work ethic, high responsibility, pride as a teacher, and self-confidence	0.91	Valid
5	Upholding the code of ethics of the teaching profession	0.91	Valid
Average CVI		0.88	Valid

Furthermore, the instrument was validated using construct validity with an exploratory factor analysis technique, and it turned out that three items failed because the anti-image correlation was less than 0.5. The instrument currently has 30 items analyzed again using the exploratory factor analysis technique, so the price of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) is 0.510. Every item has an anti-image coefficient of > 0.5, which means that all items meet the requirements to be included in the factor analysis. The second exploratory factor analysis results show that all items are accepted because they have a minimum factor load of 0.311 (Hair, 2014). The variants explained by the five factors are only 50.53%, so there are still around 47% explained by other factors.

To apply the results of this EFA in a wider area, it is necessary to do confirmation using the Confirmatory factor analysis (CFA) technique. This is consistent with the opinion of Cramer (2003), which said that EFA explores theories and CFA test theories. The CFA results show that Chi-square is lower than 2 df (333.3 < 2x372) (Arbuckle, 1997), p-value = 0.923 (> 0.05, according to Phedazur, 1997), RSMEA = 0.00 (< 0.08, according to Ferdinand, 2002), Normed Fit Index (NFI) >

0.90, Goodness of Fit Index (GFI) > 0.90. This means that the developed instrument has good construct validity. In addition to personality instruments, those analyzed using EFA and CFA are social competency instruments.

The instrument of social competence consists of four aspects, namely 1) Being inclusive, acting objectively, and not doing discrimination because of the consideration of gender, religion, race, physical condition, family background, and socioeconomic status, 2) Communicating effectively, empathically, and politely with other teachers, educational personnel, parents, and the community, 3) Performing adaption in working places throughout the territory of the Republic of Indonesia which has socio-cultural diversity, and 4) Communicating with the professional community and others verbally and in writing or other forms. The four aspects are elaborated into 33 sub-aspects that are combined with the Top ten skills and three literacies as the characteristics of the IR 4.0 era. The result of the development was then validated by 7 social science experts. The result of the expert validation is presented in Table 6.

Table 6. Expert Validation Result for Social Competence Instrument

No	Aspect	CVI	Criteria
1	Being inclusive, acting objectively, and not doing discrimination because of the consideration of gender, religion, race, physical condition, family background, and socioeconomic status	0.79	Valid
2	Communicating effectively, empathically, and politely with other teachers, educational personnel, parents, and the community	0.74	Valid
3	Performing adaption in working places throughout the territory of the Republic of Indonesia which has socio-cultural diversity	0.74	Valid
4	Communicating with the professional community and others verbally and in writing or other forms	0.75	Valid
Average CVI		0.75	Valid

Based on the results of the exploratory factor analysis, 30 items were valid, while five items were invalid. The fulfillment of the exploratory factor analysis criteria shows that the KMO value is 0.504; Bartlett's test sign. is 0.00. The valid instrument items were then tested using the confirmatory factor analysis. Hendryadi and Suryani (2014) stated that the confirmatory model factor analysis has an objective to see whether the developed model has the goodness of fit or not. The CFA results show that four valid factors have met the goodness of fit. Chi-square is lower than 2 df (265.93 < 2x269) (Arbuckle, 1997), p-value = 0.541 (> 0.05, according to Phedazur, 1997), RSMEA = 0.00 (< 0,08, according to Ferdinand, 2002), Normed Fit Index (NFI) > 0.90, Goodness of Fit Index (GFI) > 0.90.

The Developed Application

The developed application focuses on stages 5-8 of the 8 stages implemented namely; the application development, application assessment by experts, application trial, and final revision of the application.

Application Development

The application being developed is for lecturers, administrative staff, and student teachers. The display of the media is presented in Figure 1.



Figure 1. The Display of the Prospective Teacher Test Application

The display is a login page requiring e-mail and password for lecturers, administrative staff, and student teachers. The display of application for administrative staff application is presented in Figure 2.

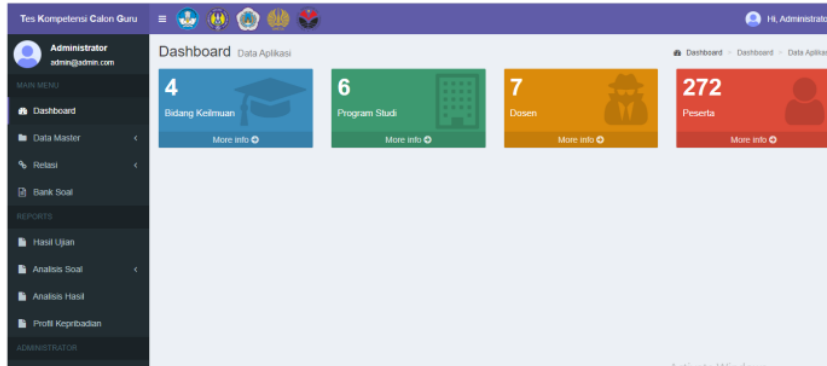


Figure 2. The Login Display for Admin

The login page in application for lecturers is presented in Figure 3.

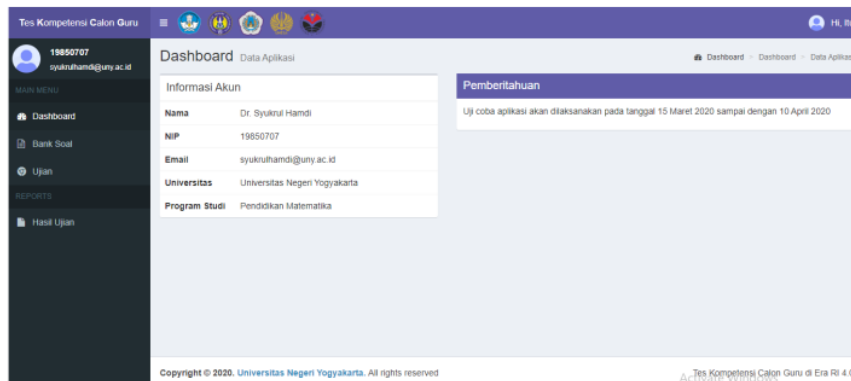


Figure 3. The Login Page for the Lecturer Application

Compared to the application for the lecturers, the application for administrative staff has more features including the access to allow lecturers to register their student teachers for a test. The display on the lecturer application menu contains a dashboard, questions, exams, and exam results. The lecturers may add some items in the question menu. The items should be under the expected competencies, namely pedagogic, professional, social, and personal competencies. This feature somewhat makes the new application different from that of previously developed. The display of alternative competencies is presented in Figure 4.

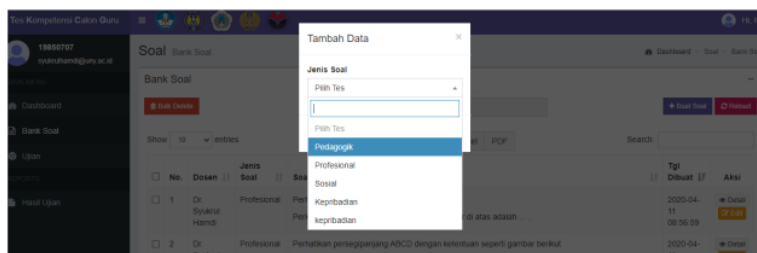


Figure 4. The Display of Menu for the Alternative Questions Uploaded by Lecturers

The lecturers are given the opportunity to input test items, yet they should be valid and reliable. Thus, test items being uploaded in the system should be first validated by experts. Another benefit of this application is that there is a menu

for uploading essays and multiple-choice questions (both dichotomous and polytomous). As some indicators cannot be measured using multiple-choice questions, essay questions are developed to be automatically checked and recorded by the system. The display of the question type is shown in Figure 5.

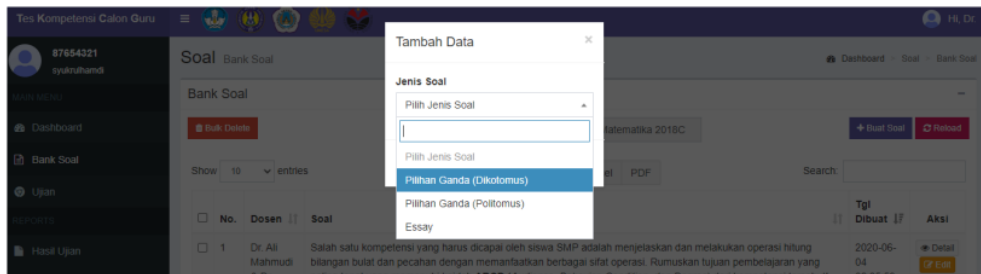


Figure 5. Alternative Question Types in the System

Various types of questions allow the lecturers to use questions in accordance with the needs of the material to be tested. In tests, some competencies require more elaborate answers, so essay questions are used instead of multiple-choice questions that determine the analysis to be used. The developed system is then evaluated by experts.

Application Assessment by Experts

Expert judgment determines the feasibility of the developed application. The tests carried out by media experts include certain assessment components which are then developed into instruments. Besides the assessment components, the experts provide input and suggestions for the improvement of the product being developed. The input and suggestions of media experts are 1). Error after login to personality and social exams; 2). The problem is immediately fixed by the team. The questions are combined, but there is still an assessment for each aspect; 3). There is a need to change the test title, the number of questions, some features for lecturer application, and time allotment. 4). Each competence scoring is separated; 5. There is a need to add some features, such as editing a test item; 6. Time management is still problematic in the system; 7. The "doubt" button is removed to make it more effective and efficient for the test respondents/participants; 8. Some questions do not appear in the system, thus there are less than 120 items.

The media experts make use of assessment instruments that consist of content, interface, navigation, configuration, and security assessment components. The assessment is conducted by 4 experts. Below are the assessment results that are converted into the assessment category.

Table 7. Result of Assessment by Media Experts

No	Aspect	Score	Category
1	Content	0.77	Good
2	Interface	0.77	Good
3	Navigation	0.75	Good
4	Configuration	0.75	Good
5	Security	0.85	Excellent
Average Score		0.78	Good

Application Trial, and Final Revision of the Application

Based on the media experts' suggestions, the application is then revised according to suggestions including fixing the error section of the system, settings for problems which are in the form of multiple-choice polytomous and dichotomous, the number of questions specified at the beginning, scoring in each competency, adding several features including features to edit the problem, some buttons removed because of ineffectiveness including the hesitant button and some other revisions.

The revised application is used to measure prospective teachers majoring in Indonesian language, English, and Mathematics. These four competencies being measured are pedagogic, professional, personality, and social competences. The instruments to measure the prospective teacher pedagogic competence and professionalism are made based on the expertise. Meanwhile, the instruments to measure the prospective teacher's social competence and personality are similar to the instruments to test prospective teachers for various subjects. The result of the test of difference using MANOVA is presented in Table 8.

Table 8. The Test of Between-Subjects Effects for Bahasa Indonesia, English, and Mathematics Pre-service Teacher Social Competence

Factor/Variable	df	Mean Square	F	Sig.	Description
A. Inclusive attitude and objective actions	2	24.191	2.910	p = .059	No Significant Different
B. Effective and polite communication	2	18.315	3.279	p = .042	Significant Different
C. Adaptation in the workplace	2	7.733	1.006	p = .369	No Significant Different
D. Communication related to the profession	2	2.599	.716	p = .491	Not Significant Different

Based on the results of the analysis above, it can be concluded that there is no significant difference between prospective teachers of Indonesian, English, and Mathematics in terms of inclusive attitudes and objective actions, adaptation in the workplace, and communication-related to the profession. Meanwhile related to effective and polite communication there are differences between prospective teachers of Indonesian, English, and Mathematics. Unlike the case with the personal competencies presented in Table 9.

Table 9. The Test of Between-Subjects Effects for Bahasa Indonesia, English, and Mathematics Pre-service Teacher Personality Competence

Factor/Variable	df	Mean Square	F Value	Sig.	Description
Acting in accordance with religious, legal, and social norms and Indonesia's national culture	2	14.196	2.437	p = .092	No Significant Difference
Presenting themselves as an honest and noble person, and a role model for students and the community	2	5.364	1.992	p = .142	No Significant Difference
Presenting themselves as a person who is steady, stable, mature, wise, and authoritative	2	1.940	.458	p = .634	No Significant Difference
Demonstrating work ethic, high responsibility, pride as a teacher, and self-confidence	2	.581	.128	p = .880	No Significant Difference
Upholding the code of ethics of the teaching profession	2	9.038	1.770	p = .175	No Significant Difference

Based on the results of the analysis in Table 9, it can be concluded that, in all factors, there is no difference in the personality competence among Indonesian Language, English, and Mathematics prospective teachers.

The results of social competence assessment for prospective Indonesian language, English, and Mathematics teachers are presented in Figure 6.

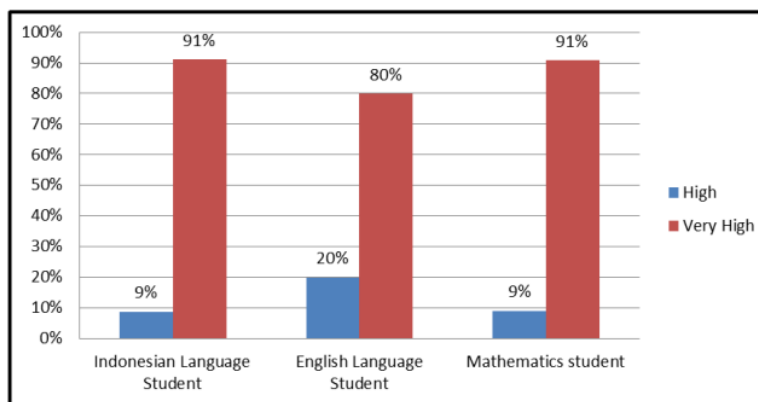


Figure 6. The Result of Social Competences Assessment for Prospective Teachers based on the Study Program

Figure 6 shows that the prospective teacher competence belongs to high and very high categories. It is confirmed through a simple interview conducted randomly on teacher students as the respondents. Besides, the universities producing pious, independent, and intellectual prospective teachers are of the TOP 20 best universities in Indonesia. Besides social competence, the developed application is integrated to measure personal competence. The prospective teacher's personality competence is presented in Figure 7.

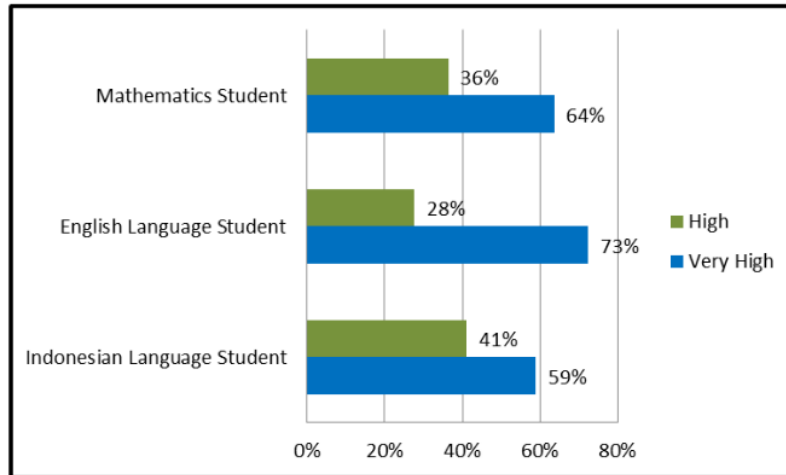


Figure 7. The Results of Personality Competence of Prospective Teachers based on the Study Program

Figure 7 shows that the average competence of teacher candidates is in high and very high categories. This is in line with the social competences of prospective teachers. Based on the results of the MANOVA analysis of personality competence, it can be concluded that there is no difference in the personality competence among prospective Indonesian language, English, and Mathematics teachers from all factors. The research respondents are not only good in both social and personality aspects, but they also have pedagogical and professional competences.

Discussion

Teachers in Indonesia must possess at least four traits namely, pedagogical, professional, social competences, and personality competences. These four competencies are crucial and complement each other. In terms of social competence, Friedlander et al. (2019) argue that teachers must teach students to pay attention to the balance of knowledge obtained at school and their attitudes in the community. Arisman et al. (2018) show that personality and professional competences are essential competencies that must be possessed by prospective teachers.

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The results showed that the instrument used to measure the personality competencies of prospective teachers in the Industrial Revolution Era (R.I. 4.0) had 30 items grouped into five factors. For social competence, it got 30 valid items grouped into 4 factors, while the instrument of Indonesian pedagogical competency consists of three aspects described into 20 sub-aspects. Moreover, Bahasa Indonesia's professional competency instrument comprises 6 aspects described into 24 sub-aspects, and the instrument of the English pedagogical competency consists of nine aspects described in 20 sub-aspects. The instrument of professional English competency consists of five aspects, whereas the instrument of professional Mathematics comprises six aspects. The six aspects are described in sub-aspects, materials, and indicators combined with the top ten skills and three literacy which are characteristic of the RI 4.0 Era. The resulting instrument already meets the validity and reliability. Besides the instruments, the initial application of the competency evaluation model of prospective teachers in Era RI 4.0 has been developed which obtained a category of proper or valid based on the assessment of media experts.

The resulting application consists of 3 important sections namely the competency application of prospective teachers managed by the admin, a special application for lecturers or instructors, and an application for the participants, in this case, prospective teacher students. Each section in question has different features, the application for admins has the most complete features and can control the features of lecturers and students. In the admin feature, it can add lecturers

and participants, providing the information related to examination terms and rules and other comments that are administrative.

The lecturers/instructors' features are not the same as admins, but the lecturer's features are more complete compared to students. In the lecturer feature, many components include the menu of Question Bank used to collect the questions that have been created. In developing the questions, it is given 4 question form options namely the question of multiple-choice dichotomous, the question of multiple-choice polytomous, the question of structured description, and the question of free description. The model of the question is directly inputted by the lecturer along with the answer key or the assessment rubric for the description question. The system will correct automatically and the results can be seen directly by the lecturer/instructor. The advantage of this application is that there are 4 forms of questions prepared for lecturers/instructors. In addition to the 4 forms of questioning, there will be directly four competencies namely pedagogical competencies, professional competencies, personal competencies, and social competencies. The results of the question input will be seen well on the student menu according to the number of questions that have been determined by the lecturer /instructor.

The next feature is designed for participants or students. In this section, the provisions or the new implementation of the exam, the exam time, and before starting the exam will be given a token by the admin or lecturer as a key to enter the exam. This is used to maintain the confidentiality of questions and the security of questions that have been stored in the system. After the token is filled in by the student/participant, the time will be displayed on the screen according to the time determined by the admin or lecturer/instructor.

This application can ease and assist lecturers or instructors to know the competencies of the Pre-service teacher. Several studies showed the importance of increasing teacher professionalism in learning in various fields by utilizing technology emphasizing in pedagogical aspects (Ajmain et al., 2019; Anagun, 2018; Chai et al., 2019; Chou et al., 2018; Ismail et al., 2018; Tican, & Deniz, 2019; Van Hong et al., 2018). The results of those studies support the idea of developing an evaluation model for the pedagogic competence conducted in this study. The developed model will serve the purpose of evaluating not only the pedagogic competence, but also three other competencies namely professional, personality, and social competences. Social competence and personality competence are very important for teachers. Social competence includes the ability to manage social relationships that require a variety of skills as well as the ability and capacity in solving problems that occur in interpersonal relationships (Boucher, 2012).

Teacher social competence provides significant impacts on several social contexts, one of which is school stakeholders, including school customers, users of school graduates, and community leaders who are very influential in the process of improving the school quality. The same impact is felt by colleagues and students whose achievements are in the hands of the teachers. Based on the results of the MANOVA analysis for social competence, it can be concluded that there are no differences between prospective Indonesian, English, and Mathematics teachers in terms of inclusive attitudes and objective actions, adaptation in the workplace, and communication-related to the profession. Meanwhile, related to effective and polite communication, there is a significant difference among prospective Indonesian language, English, and Mathematics teachers. Mathematics and Indonesian language teachers get better scores in the aspect of communicative and polite communication than prospective English teachers.

Based on the results of the MANOVA analysis of personality competence, it can be concluded that there is no difference in the personality competence among prospective Indonesian language, English, and Mathematics teachers from all factors. The research respondents are not only good in both social and personality aspects, but they also have pedagogical and professional competences. Measurement results using applications that have been developed show that the application is running well. Nevertheless, this application will continue to be refined including the addition of features that can provide convenience for lecturers who will test and student-teacher candidates who become application users. The application is expected to help the government to test the competency of pre-service teachers more effectively. It will be developed not only for competency tests but it can also be employed for exams both at school and in college, especially at this time using online learning and need a web-based assessment application that can be used online. This application is also not only used for teachers and lecturers in Indonesia but can be applied by educators/teachers/lecturers anywhere and anytime.

Conclusion

Teacher competency has been becoming the government's concern, as one of the indicators of advanced education includes qualified teachers. Therefore, a valid instrument is highly needed for evaluating teacher competency. Based on the results, it can be implied that the evaluation models designed for prospective teachers in the Revolutionary Industry 4.0 era comprise instruments for assessing four main competencies, namely pedagogical competency, professional competency, personal competency, and social competency. The instruments of these main competencies were integrated with the top ten skills and three literacy skills, including digital literacy, data literacy, and humanity literacy. The instruments which have been developed are valid. The application of instruments for assessing teacher competency has fulfilled the readability aspect and has gained a good score in expert judgment with an average score of

0.78. The application for assessing teacher competency can be utilized by the government to evaluate the prospective teacher's competency as an attempt of preparing professional teachers in the Industrial Revolution of the 4.0 era.

Recommendations

Based on this research, there are several recommendations to the government, the university leaders of LPTK / lecturers, and researchers. For the government, this developed application can be used as a comprehensive model for evaluating candidates of teachers' competencies including; pedagogical, professionalism, personality, and social competence all of which are tailored to the needs of the era of Industrial Revolution 4.0. This model can be used for the final determination of prospective teachers whether they are eligible or not to become teachers even with certain improvements in several aspects. Besides, the government is recommended to provide a continuous moral and material support to improve the developed application. Meanwhile, it is recommended to the leaders of LPTK and lecturers to optimally use the application and be a role model for the development of a more complex evaluation model.

The results of this application development are expected to be the main layer for continuous development in the improvement context, especially in the application compliment for a valid description and integrity of test participants. Therefore, it is recommended that other researchers might develop an application equipped with a test respondent detector so that the test from home or other places can be monitored through the system. Monitoring through the system is intended to prevent the fraud related to question work, to know whether they did it independently or assisted by others. The detector might use shadow detection (image sensor), voice detector, or other alternatives. The development of a valid, reliable, and easy-to-use evaluation application for online learning is needed nowadays (learning during the COVID 19 pandemic) because all schools, especially in Indonesia, are implementing online learning. Developing the application needed by teachers might solve one of the main problems in today's education.

Limitations

Some of the limitations found in this study were the absence of an appropriate detector to detect respondents who took the test from their respective homes/places so that the level of integrity/honesty of the test takers could not be detected. The detector used in the previous applications was a token for a certain test, an identity that is matched to the list and photo recording before the test. Also, the limitations of this application were only focused on evaluating the competencies of prospective teachers in the Era of RI 4.0, while the current need is not only evaluating the competence of prospective teachers but also for evaluating online learning in schools considering that almost all schools implemented online learning during the COVID 19 Pandemic.

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