Volume 15 Number 2 (2023)
July-December 2023
Page: 1089-1100

E-ISSN: 2656-9779
P-ISSN: 1907-6355
DOI: 10.37680/qalamuna.v15i2.3423

QALAMUNA
JURNAL PENDIDIKAN, SOSIAL, DAN AGAMA

Integrated Test Model on Professional Certification through Outcome-Based Education Implementation

Sukatiman [1], Jauhan Budiwan [2], Waluyo [3]

[1] Universitas Sebelas Maret, Surakarta, Indonesia; sukatiman@staff.uns.ac.id
[2] Institut Agama Islam Sunan Giri Ponorogo, Indonesia; jauhan@insuriponorogo.ac.id
[3] Universitas Sebelas Maret, Surakarta, Indonesia; waluyo@staff.uns.ac.id

Received: 10/07/2023 Revised: 28/10/2023 Accepted: 25/11/2023

Abstract

In contrast to previous research, the professional competency test of building engineering expert schemes offer blended integration assessment through the application of media mockup and ICT devices that are appropriate to the industry so that the assessment plays an active role in solving the problems to achieve the Outcome-Based Education (OBE) characteristics. The research purpose is to implement integration tests in the cognitive domain, and skills domain of the student end semester university to reach competence according to the Indonesian Standard of Professional Certification (BNSP). The research uses a mixed method, consisting of descriptive quantitative to analyze the data collection before and after the implementation model integration test, and qualitative to have deeper findings of research. The result of the competency test for understanding the planning guidelines in reinforced concrete structures (SNI) after using the mockup media showed that the participants were 16 assesses, were 8 students in the competent category, 7 students were included in the good competent category, and 1 student was included in the excellent competent. This research concluded that All of the assessees passed the competence level on their national professional certification competence (BNSP).

Keywords Assessment; Certification; Competence; Outcomes Based

Corresponding Author
Sukatiman
Universitas Sebelas Maret, Surakarta, Indonesia; sukatiman@staff.uns.ac.id

Published by Institut Agama Islam Sunan Giri (INSURI) Ponorogo; Indonesia
Accredited Sinta 2

1. INTRODUCTION

In the current new normal era, the learning process in an engineering field is not efficient if one relies solely on IT, because their comprehension of the actual structure building has not been acquired well. To overcome the problem of structure-building comprehension by assessing, the utilized a technology-based instrument is needed, it is because learning at Industry 4.0 should be based on Outcome-Based Education (OBE). Skills to apply technology and information media in the work, and adaptability to utilize their competence are very important (Artiningsih & Nurohman, 2020; Herodotou et al., 2019).

The OBE learning system has been applied globally, to tackle the vast development era of the 4.0 industrial revolution, accreditation, and higher education institutions have adopted the approach of OBE as a platform for accreditation engineering program enhancement. The OBE becomes the basis of the world to achieve international accreditation, such as the Accreditation Board for Engineering and Technology (ABET) in the US, the Australian Graduate Attributes which regulates Australia Engineering Accreditation (2005), and the Engineering Accreditation Council (EAC) is solely responsible to accredit the engineering of Malaysia (BEM). The other example is the Philipines whose learning curriculum has changed into OBE through the Commission of Memorandum. The CMO article number 46 of 2012, regarding "Policy Standard to Enhance Quality Assurance in Philippine Higher Education through an Outcome-Based and Typology Based QA" (Vernon & Nunnally, 2017). However, the accreditation institution adopted more is ABET, a benchmark to many institutions outside the United States (US), including universities in Indonesia (Retnanto et al., 2018). Furthermore, another reputable engineering accreditation used as a standard in the engineering sector in Indonesia is the German Accreditation Agency for Study Program in Engineering, Informatics, Natural Sciences and Mathematics (ASIIN), (Senthil Kumar & Sivakumar, 2014). The eight aspects of the accreditation system applied by ASIIN are the general requirements (ASIIN, 2019), which enable the students who do not study abroad to get the "European Engineers" degree (Tang et al.2014).

Every higher education institution in Indonesia must have a duty to take part in national accreditation. The Indonesian Accreditation Standards Higher Education includes the competency requirements of professional lecturers in the Main Performance Indicator (MPI) 4th. One of the requirements obliges an engineering graduate to have the National Professional Certification Agency (BNSP) certificate (Decree of the Minister of Education and Culture of the Republic of Indonesia No 83 of 2013). Yet, the partnership implementation of Sebelas Maret University and BNSP has just been conducted in 2020. The OBE is a student-centered teaching and learning methodology in which the learning process and assessment aim to achieve specific goals and outcomes (Thirumoorthy, 2021). The OBE curriculum requires determined learning outcomes before teaching and a sustainable attempt to monitor all learning phases, content, instructional strategies, learning experiences, and evaluation methods (Gurukkal, 2020).

Oyebode (2021) defined OBE as the program outcomes that describe the desired knowledge and the skills that the students want to achieve after they graduate. The education means that the quality and satisfaction of the class can be very different both in terms of instructors and the material (Han & Sa, 2021), including the spontaneous learning changes where lecturers and students are not accustomed to using models and learning aids that facilitate the learning process and the assessment. One of the efforts is developing an evaluation model where the achievement of competence applies OBE stated that the ideal learning achievement is successful when it shows an advisable result compared to the accomplished competencies. Therefore, this research presents the mockup of a scaffold for the assessment before they conduct the real evaluation. Mockup in this research is a prototype model teaching aid that represents the existing building conditions and can give an actual picture of the real situation (Gui et al., 2020).

Mockups as a visual aid commonly used for learning and training activities have various benefits

if used according to the characteristics of the material and the students ((Christensen, 2002); Qureshi et al., 2021). The results of research conducted by Istiqomah & and Permanasari (2021) stated that teaching aids can be used for learning science such as physics. According to him, the teaching aids that are developed must first be adapted to the characteristics of the material so that it can make it easier for students to understand the material that is abstract and tends to the structural. Apart from that, visual aids can also be used in other learning if they first go through needs analysis activities (Septioningrum et al., 2022).

Other research has also succeeded in proving that visual aids can be in a form that is integrated with the computer as a source for learning, and these findings state that the use of teaching aids in the learning process can effectively increase students' understanding of learning materials, which it is indicated that many students then easily remember important things from the material they are learning (Bilousova et al., 2021; Howe et al., 2019). The findings of some research regarding the benefits of visual aids in learning can certainly become the basis and frame of mind so educators should start using visual aids as an alternative learning resource that can help students understand the material and achieve the competencies needed in the 21st century.

One characteristic of OBE is student-centered learning to eliminate the lack of traditional learning, where the student is strong in theory but lacks practical skills (Hu et al., 2023). Therefore, this study presents a new approach to fostering students' learning abilities through the application of demonstrations with industry-appropriate equipment. Referring to various relevant findings and a synthesis of the observed field facts, the research aims are to create a model test to achieve competence in the cognitive and skills domains of the assessee in the field of multiple-story building structures.

2. METHOD

Research Design and Participant.

This research is a mixed method, with an exploratory sequential design where the quantitative phase helps inform the qualitative phase (McKim, 2017). The adoption of this design is expected to be able to obtain an overall picture both qualitatively and quantitatively related to the impact of the developed teaching aids. The study development of the OBE assessment is held for 1 year involving a team researcher and 3 students from the end semester undergraduate program who arrange the thesis. Respondents of this study were UNS students who registered to test professional competence as Building Engineering Experts (ATBG) consisting of students from the Civil Engineering Education Study Program, the Civil Engineering Study Program, and the Vocational Civil Engineering Diploma-three Vocational Study Program 32 total number participants. The participants were the assessees (the college students at the end semester) who have experience in an industrial field study, and have registered and followed test competence to get one professional competence certificate (Indonesian national standard certificate= BNSP) as the prerequisite of the students apply and accepted in industrial.

Product Specification and Data Analysis.

The developed mockup is a two-floor building reinforcement structure consisting of slab reinforcement, beam reinforcement, and column reinforcement. The mockup changes the actual building structure with a dimension 4 meters in length, 3 meters wide, and 4 meters height by reducing the dimensions scale of 1:5. The mockup material consists of concrete molds using acrylic, slab reinforcement using wire with a diameter of 1 mm, concrete steel reinforcement using electrical wire, and concrete decking using rubber. For ease of discussion, the mockup is available in each element as well as a slab, column, and balk so that 2 to 3 participants to ensure student active, cooperative, and collaborative learning. The application of the mockup for self-assessment is held before the test competency and aims to provide the teaching instruments to help the assessed students recall the theory that they received during the process of learning or to understand in more detail the actual structure in

the field. The self-assessment consists of 25 questions developed from the 1971 Indonesian Concrete Regulations combined with the 2017 Concrete Regulations. The cohort discussion is finished when all the participants pass the minimum standard achieved is ≥75.

After the students pass the independent exam, they will have to continue to an integrated assessment using an instrument developed regarding the BNSP (National Institution for Professional Standardization) method which integrates the material developed from the Indonesian National Framework Competency Standard (SKKNI) for the job position of a Building Engineer level 5 and 6. The time of the data collection is based on the professional certification exam at Sebelas Maret University (UNS) professional certification body (LSP-UNS) which was held every 2 months.

The data collection is carried out by giving integrated questions to all participants including written questions, oral questions, simulation questions, and demonstration questions. The assessed answers the questions given and the examiner gives a checklist on the institution's standard score. The standard competency level of the UNS campus consists of excellent competent (scores 85-100 (A) and score 80-84(A-), good competent scores 79-75 (B+), Competent scores 70-75 (B), and not competent scores <70). The collected data are then analyzed using mixed methods, where qualitative used to analysis for observations data and integration tests, and quantitative descriptive used to analyze the data which are in the form of learning outcomes scores. Student results scores were then compared to get the average final score between the pre-test before using a mockup and the post-test after using the mockup.

3. FINDINGS AND DISCUSSIONS

Findings

The Development of the Outcome-Based Education.

The new plan for the curriculum profile mapping of Civil Engineering Education (CEE) graduates before and after the implementation of independent learning is different. The mission of the program study before the implementation of Independent Campus of Learning Independent (MBKM) is only to prepare vocational educator graduates. On the other hand, the curriculum objectives after the implementation of independent learning (MBKM) are a) undergraduate educators with additional entrepreneurial abilities, b) undergraduate educators with additional skills of drawing experts, and c) undergraduate educators attributed with the skills of construction experts. In achieving the MBKM objectives, Sebelas Maret University has established a professional certification institution named "Professional Certification Institution-Sebelas Maret University" (LSP- UNS).

Civil Engineering Education (CEE) is one of the study programs handling the Competency Unit (UK) established by Sebelas Maret University (UNS) with the Building Engineering Expert (ATBG) certification scheme. The ATBG scheme is a certification with beneficial prospects because currently responsible for professional certification to the students of the Civil Education Engineering (CEE) undergraduate study program in collaboration with the Civil Engineering (CE) undergraduate study program, and Vocational Civil Engineering (VCE) study program of UNS vocational college. All the engineering programs above are classified as Technical Vocational Education and Training (TVET).

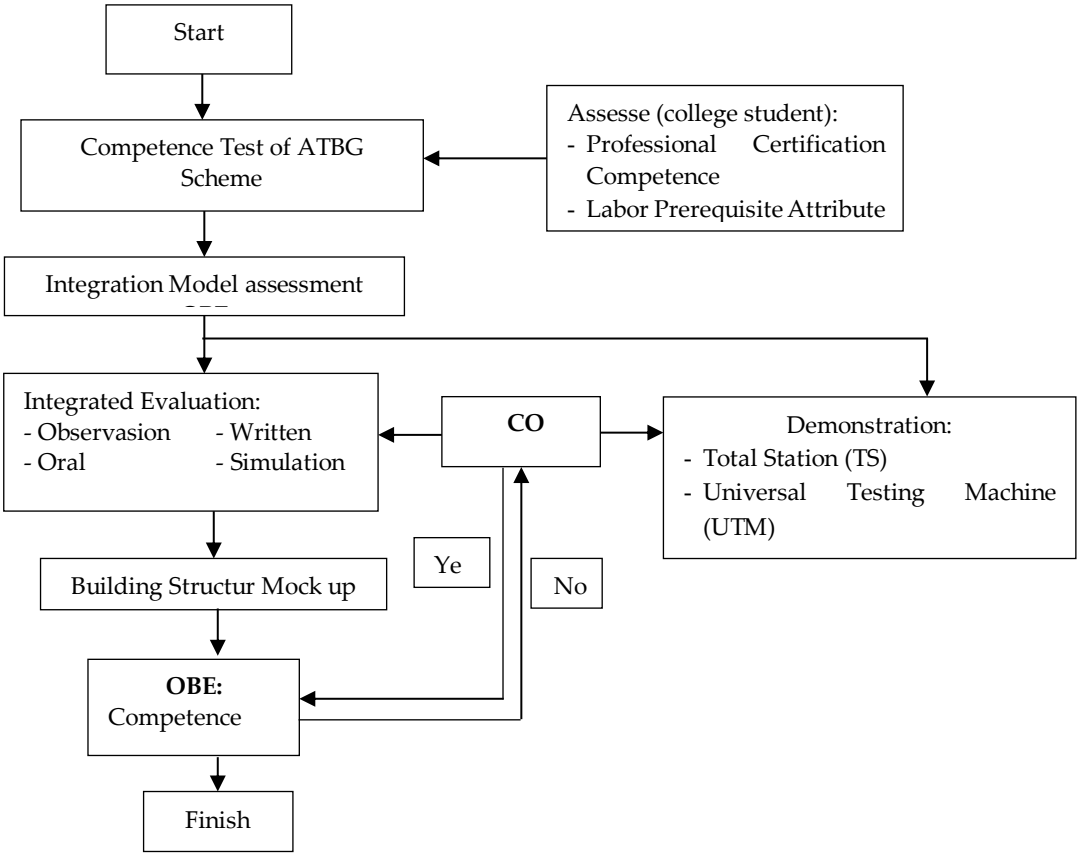

Figure 1. Research Procedures Assessment Based on OBE.

In which:

UTM, digital Technology = Universal Testing Machine.

TS, digital Technology = Total Station, Survey, and mapping Apparatus.

ATBG Scheme = Expert scheme on Building Engineering.

The Instrument Model to Achieve OBE

The design mockup is used in self-assessment to answer questions related to the SNI standard. 25 multiple-choice questions must be answered by the assessment through discussions with colleagues and SNI standards. Through the discussion in class, the students could share their ideas so that they will have a better understanding of the concepts (Syarifuddin & Atweh, 2021). The challenges faced by teachers include student acceptance, lack of teaching aids, teaching strategies in the classroom, and students' thinking skills (Kim How et al., 2022). The results of research findings about the lack of use of teaching aids can help researchers correct some shortcomings, including weak students in learning higher-order thinking skills (HOTS).

This assessment uses a mockup to give the student an understanding of the structure in a particular situation such as the industry restriction or unreadiness. By applying the visual aids, the assessments have an intrinsic to discuss with a cohort to answer the multiple-choice question given, based on the reinforced concrete structure SNI standard. Furthermore, the assessor can ask to participants simulate the assignment.

To get The OBE in evaluation, the participants must be competent in Technology-based learning devices that match with the civil construction industry. The devices that have to be demonstrated to the participants consist of 1) the Universal Testing Machine (UTM) to test the quality of concrete; 2) the Total Station (TS) is an optical-based tool to determine the level, perpendicular, and height of building

structures.

Result of Integrated Competence Test

The development of an integrated competency test is the characteristics of the questions that refer to the BNSP guidelines. The integration questions consist of planning questions, competency tests for drawing skills with AutoCAD, skills tests carried out through tools utilization assessment (performance tests), and simulation tests.

Table 1. Integrated Test

No.	Integrated Assessment	Mean ± M
A	**Planning (Written Test)**	
1	To Plan the steel rafter with a double Elbow (2L) profile	78,48-1,32
2	To draw the structure of the beam, with the Autocad application	78,48+1,32
3	To comprehension of beam reinforcement	78,48-1,95
4	To Analysis of the reinforcement material needs	78,48-2,95
5	To check the number of reinforced concrete compared with beam-wide accordance of SNI	78,48-4,28
B	**Implementing (Oral Test)**	
6	To grasp planning of shop drawing	78,48+6,45
7	To synthesize the student knowledge in implementing method of the column reinforcement	78,48+1,38
8	To analyze the students' knowledge about portal moment force	78,48+0,72
9	The student evaluation of Health and safety work through the field photo document	78,48+2,05
10	To evaluate the student's understanding of casting readiness, concrete casting, and curring	78,48-1,55
C	**Supervising (simulation Test)**	
11	To analyze the student competence of provisional Hand Over (PHO) and Final Hand Over (FHO)	78,48-1,08
12	To keep the student in architectural works	78,48+1,44
13	To evaluate the student knowledge in composite reinforcement	78,48-0,88
14	To Play as the fieldwork coordinator	78,48-0,95
D	**Demonstrating (Performance Test)**	
15	Procedure standard operating UTM	78,48+8,60
16	Procedure Standard operating Total Station (TS) theodolite	78,4+10,10

The design of the competency test questions is correlated with the assessment based on higher-order thinking skills (HOTS) which is the base of the Outcome Based Education (OBE) assessment (Table 1). The minimum achievement standard (KKM) required is 75, to be eligible competent. The consideration of the competence is based on the fact that the assessee has completed all the engineering courses which are the basic competence to enter the industrial field. The quality of the questions is raised to provide an evaluation focus where the student can achieve excellent competence or still needs improvement. The confidential competency test is conducted in one face-to-face exam. The results of the competency test are immediately announced to the assessee whether the recommended assessee is competent or incompetent.

By comparing the results of the integration test before and after using the mockup, the following results are obtained:

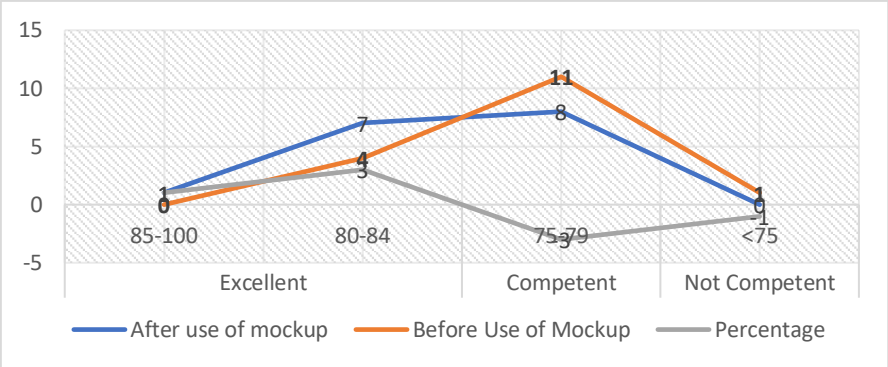

Figure 2. Graphic of Combination of Integrated Competence Assessment

In the integrated competency test shown in Figure 2, the questions were given more fully to the assessee including the structure and planning understanding, SNI understanding, work implementation organization, Occupational Health, and Safety (K3), and project management (table 1). The results of Figure 2 show a comparison of learning outcomes between students before using mockup props which are marked with orange lines (black and white printouts) and students who have used mockups which are marked with blue lines. The graphic results show that there is an increase in the achievement of learning outcomes from students who have not used a mockup after using a mockup. It was described that before using the mockup, 1 student was included in the not competent category, 11 students were included in the competent category, and 4 students were included in the excellent competent category. These results then changed after students used mockups as teaching aids in learning activities, where 8 students were included in the competency category, 7 students were included in the good category, and 1 student was included in the excellent category with a score of 85-100. This proves empirically that the use of mockups has a positive impact on improving student learning outcomes, in the form of increasing the competencies set during the training program.

The result of the competency test for understanding the planning guidelines in reinforced concrete structures (SNI) showed that Excellent Competent increased by 4 participants (27%), Competent by 5 participants (31%) decreased by 3 participants, and Not Competent decreased by 1 participant or all participants passed the exam (100%).

Discussion

One of the characteristics of OBE is HOTS-based assessment, and learning evaluation plays an important role for assessors to identify whether the students have achieved a good teaching method and any things needed to improve the learning in their class (Guskey, 1994). The learning outcomes in higher education programs are defined in three levels, as a result of Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs). The most important aspect of outcomes is that learning must be observed and measured (Rao, 2020).

In this study, OBE is focused on measuring Course Outcomes (COs) through selected HOTS Questions at the analysis, evaluation, and creative thinking (Sukatiman et al., 2020; Utama et al, 2020). Xiong & Suen (2018) confirmed that evaluation was beneficial to recording students' performance and producing a precise, and accurate scoring to yield the competence certificate. There are 5 indicators required to achieve a competent level developed by BNSP. The five dimensions of competence in question consist of 1) Task Skills (TS), which are the skills to carry out individual tasks according to standard operating procedures (SOP). The Assessment consists of the question of planning for the slab-reinforced concrete. This question is categorized as a high-level question because it involves students' knowledge of analysis loading theory, calculating bar forces, selecting eligible bars, and calculating the safety number of the structure.

From this question, it can be classified as level 6 according to Bloom at the evaluation level. These

types of planning questions are in the BNSP category in Task skills. In competency task skills, the assessee must be able to demonstrate the individual ability to complete a work plan. Task skills in integrated questions are also shown in drawing assignments with AutoCAD whereas in the industrial field, the ability to draw and analyze portal structures with computer applications must be mastered. 2) Tasks Management Skills (TMS), are the skills to manage several different tasks (>1) in one job (managing work processes). Assessment consists of written questions with the type reading of the reinforcement beam given in the form of a shop drawing. The task of the assessment is to calculate the required reinforcement bar volume based on the shop drawings on the available form. This type of question includes HOT skills questions (levels 4-6) which are industrial-based, to make participants skilled in planning the needs of reinforced concrete materials. This question is categorized in Task Skills Management because it involves several types of fieldwork that must be mastered by the assessee. 3) Contingency Management Skills (CMS), are the skills to respond and to overcome anomalies, irregularities, and problem-solving (if an anomaly occurs in the field, what you will do?). Assessment consists of tasks for the students to understand architectural work as a functional support of a building (mechanical and electrical work). At this stage, the assessee is equipped with managerial skills in leading and coordinating a job to produce a building function that is appropriate to SNI standard requirements. At this level, the assessment must be careful in terms of the leak test, and architectural functional feasibility test that will be handed over for the first stage (Provisional Hand Over = PHO). 4) Job roles Environment Skills, are the skills to responsibilities and expectations adapt to the work environment. Complete work results when implementing POS. The assessment question is an oral test to strengthen the depth comprehension of the assessee in their knowledge related to their adaptation to their work responsibilities and training the assessment to adapt to the work environment. The assessor's question can be in the form of how the assessee shows responsibility for Occupational Health and Safety (K3) by the company's target, which is Zero Accident (Los Pinos et al., 2021). 5) Transfer Skills (TRS), is the skills to adapt to the new work environment, technology, and work equipment.

Assessment consists of a demonstration question that is applied to the certification test to answer the concept of Task Skills. This assessment has the aim to carry out work according to the Procedure Operating Standard (POS). In this competency test, the assessee is asked to demonstrate the correct procedure for arranging slab reinforcement, beam reinforcement, and column reinforcement using mockup simulations. The demonstration test also requires the assessment to be able to operate technology-based equipment, such as the Teodholite Total Station (TS), and Universal Testing Machine (UTM). The objectives of this demonstration are to practice familiarity with the operation of equipment suitable for the industrial field. This demonstration session in the BNSP guide is included in Transfer Skills (TRS), where the student can adapt to the use of industry-appropriate technological equipment and improve innovation ability (Yin et al., 2022). Performance test conducted in evaluation is good due to every assessment having a self-experience that closely or even matches with the industry (Pradhan, 2021; Premalatha, 2019).

The result of the competency test development 1 to 5 about the understanding of the planning guidelines in reinforced concrete structures based on the Indonesian Concrete Planning Guidelines is suitable for Jossberger et al. (2015) which showed that teaching instruments made by teachers and students that implemented as workplace simulation will independently give better enthusiasm in the learning process and confidence of students' capability. Rhezeda (2016) proposed to determine exactly what a student should achieve in terms of "educational forms" and "diagnostic procedures" which referred to the way they achieved it and the way they demonstrated achievements.

The achievement graphic in Figure 2 shows that the combined evaluation before and after using the mockup, the integrated assessment, and the civil engineering device update proved that using integration assessment through the OBE gives the increasing student harvest at their competence. The finding of the investigation shows that the characteristics of OBE revealed through the integration test, consist of scaffolding by the mockup before the real test to accommodate the slow learner, medium

learner, and advanced learner (Gundalia, 2022), and match with Senaratne & Gunarathne (2019) investigation, that report of learning outcomes shows the development or growth achieved by students after completing a study program must be specifically identified). Keinänen et al. (2018) strengthen that competency innovation in higher education consists of 5 new dimensions:1) creative problem solving, 2) systems thinking, 3) goal orientation, 4) teamwork, and 5) network competency.

All discussions above will give the information to the teacher and researcher on how the best practice in TVET professional certification can be carried out, and the progress of The Indonesian OBE not only prioritizes input-output, but has comprehensively planned, monitored, and evaluation (input-process-outcome) an integration that must be fulfilled (Sasipraba et al., 2020). By implementing OBE in professional certification assessment we ensure that the student will perform the best in the industry when they find the complex problems.

4. CONCLUSION

The work highlighted in performing of test model professional competence at the Building Engineering Expert Scheme (ATBG) used integration test of the BSNP model (observation, writing test, and oral test) strengthened with teaching aids (mock-up and Civil Engineering program Application) to improve assesses knowledge acquisition. Furthermore, demonstrating operating Civil Engineering devices appropriate to the industrial gives the participants a go to the skills acquisition. The research also showed that the integration test makes the participants acquire creative thinking that is classified as the Higher-Order Thinking skills (HOTs) which is the goal of learning (OBE).

The limitation of this research is not all the students are interested in registering for a professional certification, so an attribute minimum of one student one professional certification was not reached. The other limitation is that the Program Education Outcome (PEO) which monitors the success of graduates over a period of 2-3 years of graduation still many students are not eligible to work in the workplace.

REFERENCES

Artiningsih, A., & Nurohman, S. (2020). Analysis of investigative skills based on the use of tracker video analysis for 21st-century skills. Journal of Science Education Research, 3(2), 81–86. https://doi.org/10.21831 /jser.v3i2.30621.

ASIIN, (2019). Accreditation with ASIIN – Degree Programmes, Institutions and SystemsTechnical Committee 06 – Industrial Engineering.

Bilousova, L., Gryzun, L., & Sivochka, I. (2021). Petri Nets Android application as a mobile aid for students' mastering modeling. *Journal of Physics: Conference Series*, *1840*(1). https://doi.org/10.1088/1742-6596/1840/1/012033

Christensen, R. (2002). Effects of technology integration education on the attitudes of teachers and students. Journal of Research on Technology in Education, 34(4), 411–433. https://doi.org/10.1080/15391523.2002.10782359

Gui, C., Yan, D., Guo, S., & An, J. (2020). Development of Prototype Building Model in Beijing Based on Actual Energy Consumption. Environmental Science and Engineering, March 1187–1196. https://doi.org/10.1007/978-981-13-9528-4_120.

Gundalia, M. (2022). Assessment of Course Outcomes Attainment using Confidence Limits. Journal of Engineering Education Transformations, 35(3), 21–29. DOI: 10.16920/jeet /2023/v36i4/ 23121.

Gurukkal, R. (2020). Outcome-Based Education: An Open Framework. Higher Education for the Future,

7(1), 1–4. https://doi.org/10.1177/2347631119886402.

Guskey, T. R. (1994). How Classroom Assessments Improve Learning. Educational Leadership, 51(6), 51–54. https://uknowledge.uky.edu/edp_facpub.

Han, J. H., & Sa, H. J. (2021). Acceptance of and satisfaction with online educational classes through the technology acceptance model (TAM): the COVID-19 situation in Korea. Asia Pacific Education Review, 0123456789. https://doi.org/10.1007/s12564-021-09716-7.

Herodotou, C., Sharples, M., Gaved, M., Kukulska-Hulme, A., Rienties, B., Scanlon, E., & Whitelock, D. (2019). Innovative Pedagogies of the Future: An Evidence-Based Selection. Frontiers in Education, 4(October), 1–14. https://doi.org/10.3389/feduc.2019.00113.

Howe, C., Hennessy, S., Mercer, N., Vrikki, M., & Wheatley, L. (2019). Teacher–Student Dialogue During Classroom Teaching: Does It Impact on Student Outcomes? *Journal of the Learning Sciences*, *28*(4–5), 462–512. https://doi.org/10.1080/10508406.2019.1573730.

Hu, A., Mao, X., Fu, C., Wu, M., & Zhou, S. (2023). Engineering Curriculum Reform Based on Outcome-Based Education and Five-Color Psychology Theory. Sustainability (Switzerland), 15(11). https://doi.org/10.3390/su15118915.

Istiqomah, Anna Permanasari, I. D. P. (2021). *Development of Learning Media for Formalin Test.Teaching Aids To Increase Interest in Learning and Chemical Literacy of Smk Students*. *5*(2), 74–82. Journal Science Education and Practice. DOI:10.33751/jsep.v5i2.5700.

Jossberger, H., Brand-Gruwel, S., van de Wiel, M. W. J., & Boshuizen, H. P. A. (2015). Teachers' Perceptions of Teaching in Workplace Simulations in Vocational Education. In Vocations and Learning (Vol. 8, Issue 3). https://doi.org/10.1007/s12186-015-9137-0.

Keinänen, M., Ursin, J., & Nissinen, K. (2018). How to measure students' innovation competencies in higher education: Evaluation of an assessment tool in authentic learning environments. Studies in Educational Evaluation, 58(May), 30–36. https://doi.org/10.1016/j.stueduc.2018.05.007

Kim How, R. P. T., Zulnaidi, H., & Rahim, S. S. A. (2022). HOTS in Quadratic Equations: Teaching Style Preferences and Challenges Faced by Malaysian Teachers. European Journal of Science and Mathematics Education, 10(1), 15–33. https://doi.org/10.30935 /SCIMATH/11382.

Los Pinos, A. J. C. De, González-García, M. de las N., Pentelhão, L. C., & Baptista, J. S. (2021). Zero-risk interpretation in the level of preventive action method implementation for health and safety in construction sites. International Journal of Environmental Research and Public Health, 18(7). https://doi.org/10.3390/ijerph18073534.

McKim, C. A. (2017). The Value of Mixed Methods Research: A Mixed Methods Study. *Journal of Mixed Methods Research*, *11*(2), 202–222. https://doi.org/10.1177/1558689815607096.

Pradhan, Devasis. (2021). Effectiveness of Outcome Based Education (OBE) toward Empowering the Student's Performance in an Engineering Course. Journal of Advances in Education and Philosophy, 5(2), 58–65. https://doi.org/10.36348/jaep.2021.v05i02.003.

Premalatha, K. (2019). Course and Program Outcomes Assessment Methods in Outcome-Based

Education: A Review. Journal of Education, 199(3), 111–127. https://doi.org /10.1177/0022057419854351.

Qureshi, I., Pan, S. L., & Zheng, Y. (2021). Digital social innovation: An overview and research framework. *Information Systems Journal*, *31*(5), 647–671. https://doi.org/10.1111/isj.12362

Rao, N. J. (2020). Outcome-based Education: An Outline. Higher Education for the Future, 7(1), 5–21. https://doi.org/10.1177/2347631119886418.

Retnanto, A., Parsaei, H. R., & Parsaei, B. (2018). Engineering accreditation: Assessing and documenting student's competencies in their respected disciplines. Proceedings of the International Conference on Industrial Engineering and Operations Management, 2018- March, 854–856. https://link.springer.com/book/10.1007/978-3-030-78570-3.

Rhezeda, M. Khusainova., Pavel N. Afanasyef., Natalya N.Novik., Svetlana E.Chirkina., Milyausha R.Hajrutdinova., Valentina A. Samsonova & Olga G. Lopukhova (2016). Developing model of training Vocational NC. DOI:10.21831/amp.v6i2. 17136.

Sasipraba, T., Kaja Bantha Navas, R., Nandhitha, N. M., Prakash, S., Jayaprabakar, J., Poorna Pushpakala, S., Subbiah, G., Kavipriya, P., Ravi, T., & Arunkumar, G. (2020). Assessment tools and rubrics for evaluating the capstone projects in outcome-based education. Procedia Computer Science, 172(2019), 296–301. https://doi.org/10.1016/j.procs.2020.05.047.

Senthil Kumar, M., & Sivakumar, P. (2014). Enhancing the quality of technical education accreditation system using current communication system. International Journal of Applied Engineering Research, 9(23), 20421–20432. DOI:10.37622/000000.

Septioningrum, E. N. I., Risdianto, E. &dan Mayub, A. (2022). Analisis Kebutuhan Terhadap Pengembangan Alat Peraga Pada Materi Ayunan Sederhana Berbasis Arduino Uno. *Jurnal Ilmiah Pendidikan Fisika*, *5*(2021), 74–82. DOI: http://dx.doi.org/10.20527

Sukatiman, S., Akhyar, M., Siswandari, & Roemintoyo. (2020). Enhancing higher-order thinking skills in vocational education through scaffolding-problem based learning. Open Engineering, 10(1), 612–619. https://doi.org/10.1515/eng-2020-0070.

Syarifuddin, H., & Atweh, B. (2021). The Use of Activity, Classroom Discussion, and Exercise (ACE) Teaching Cycle for Improving Students' Engagement in Learning Elementary Linear Algebra. European Journal of Science and Mathematics Education, 10(1), 104–138. https://doi.org/10.30935/scimath/11405.

Tang, Y., Xu, B., Dong, X., & Shen, N. (2014). Promoting the Construction of the Experiment Center of School of Optical-electrical and Computer Engineering through ASIIN Accreditation. Proceedings of the 3rd International Conference on Science and Social Research, 1(Icssr), 198–201. https://doi.org/10.2991/icssr-14.2014.48.

Thirumoorthy, G. (2021). View of Outcome Based Education (OBE) Is Need of the Hour.

Utama, C., Sajidan, Nurkamto, J., & Wiranto. (2020). the instrument development to measure higher-order thinking skills for pre-service biology teachers. International Journal of Instruction, 13(4), 833–848. https://doi.org/10.29333/iji.2020.13451a.

Vernon, P. E., & Nunnally, J. C. (2017). Educational Measurement and Evaluation. British Journal of Educational Studies, 13(2), 212. https://doi.org/10.2307/3118345.

Wirjawan, J. V.D., Pratama, D., Pratidhina, E., Wijaya, A., Untung, B., & Herwinarso. (2020). Development of smartphone apps as media to learn impulse-momentum topics for high school students. *International Journal of Instruction*, *13*(3), 17–30. https://doi.org/10.29333/iji.2020.1332a

Xiong, Y., & Suen, H. K. (2018). Assessment approaches in massive open online courses: Possibilities, challenges, and future directions. International Review of Education, 64(2), 241–263. https://doi.org/10.1007/s11159-018-9710-5.

Yin, Z., Wu, Z., Li, D., Zhao, Y., & Liu, J. (2022). Research on the Talents Education Scheme Based on Integration of Science and Education for Information and Communication Engineering. International Journal of Information and Education Technology, 12(4), 359–364. https://doi.org/10.18178/ijiet.2022.12.4.1627.