Evaluating mechanical engineering learning through digitalization

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Abstract. Digitalization is one of the signature marks in the industrial revolution era 4.0. This cover several aspects of life, including mechanical engineering. In relation to the evaluation of mechanical engineering learning, digitalization is lesson study is inevitable. This paper investigates the development and implementation of digital platforms in lesson study for mechanical engineering learning. A collection of a variety of digital platforms were identified and analyzed. The results showed that even though mechanical engineering learning is shifting to digital learning, some still find it difficult to adapt. Therefore, it is strongly recommended that user-friendly applications, particularly mobile-based ones, be developed.

1. Introduction

The teacher has a strategic position to improve the quality of education because the teacher is the direct implementer of education and learning. When carrying out their duties, teachers must have the competence to support the teaching and learning process. Teachers regarded themselves as coache. Appropriate learning arrangements can increase teacher motivation to use new teaching methods so learning is more effective. It has a positive influence on increasing the competence of professiona teachers. Education in Indonesia is still being debated by various observers of education. The inequality of education is still a fact found in various parts of Indonesia, with various obstacles that have surfaced and become a hot issue about education in Indonesia. Indonesia's position which ranks 110th out of 177 countries reported by UNDP in 2005 is quite alarming for many people who are trying to find the root causes of quality below neighboring countries such [1] as Singapore (rank 25), Brunei Darusalam (rank 33), Malaysia (ranking 61), Thailand (rank 73), Philippines (rank 84) and Vietnam (rank 108). Opinions of several speakers on various occasions discussing the quality of education have long been put forward that the quality of education in Indonesia is still very low in the level of competition and relevance [2-4]. Although many attempts have been made by the Government of Indonesia to improve the quality of education including making changes or revisions. curriculum, partnership programs, improvement of teacher and lecturer qualifications, teacher and lecturer certification, and many other programs are carried out, but these efforts have not shown significant results. Efforts to improve education still seem not to fully pay attention to the conception of learning and learning which should start from how students and teachers learn and how teachers teach, not solely on learning outcomes [5]. In line with what was
stated by Podhorsky and Moore states, that education improvement should be interpreted as an effort to create programs that focus on improving teaching and learning practices, not merely focusing on class design by delivering the curriculum as it is [6].

Teachers should create more professional development programs by utilizing facilities that can provide opportunities for them to learn how to learn and to learn about teaching, for example by facilitating teachers to develop Lesson Study (LS) or study learning. LS provides a way for teachers to be able to improve learning systematically [6]. LS provides a process for collaborating and designing learning and evaluating the success of teaching strategies that have been implemented in an effort to improve student learning processes and gains. The use of the LS process with professional development programs is a vehicle for returning teachers to a proportional teaching culture [7].

Vocational High School teachers in mechanical engineering productive programs have specific professional characteristic and requirements, namely (1) Having adequate practical expertise in all productive study areas, (2) Able to organise learning (training) that is relevant to the competencies needed by the world of work and (3) Able to design learning (training) in schools and business or industry [2]. The role of Vocational High School teachers is primarily as a facilitator in making the learning atmosphere so that the process according to the learning plan is to develop student competencies. Teaching is primarily the effort of the teacher in creating conditions or regulating the right environment so that interaction occurs between students and their environment, including teachers, facilities and appropriate learning media [6]. Teacher-centred learning, textbook-driven approach encouraged passive learning of discrete facts and isolated knowledge [8].

2. Literature review
LS is a process of developing professional competence for teachers that is systematically developed with the main objective of making the learning process better and more effective [9]. According to Stigler and Hiebert [10], LS generally follows 8 main steps, namely: 1) defining the problem, this can be applied in general, for example how to make students like physics lessons, or special problems, for example how to make students understand Theory of Relativity Einstein; 2) planning the teaching and learning process (PBM), this process is carried out jointly and collaboratively between group members, with the aim of finding the best solution of the problem; 3) implementing PBM, this process is carried out by one of the teachers while the other members act as observers who record the behavior of students and things that occur during PBM; 4) discuss and reflect on the new PBM process, this activity aims at evaluating the PBM process, especially on the application of alternative solutions to problems, 5) revising the PBM plan, from the reflection results the group members return to work together to make a PBM plan can give better results than before; 6) implementing PBM again to try out the newly drafted PBM plan, at this stage an external observer can also be invited to provide opinions and suggestions for the further development of solutions; 7) further evaluation and reflection to again discuss the various results of applying the solution to the PBM that have been implemented; and 8) share the results of these experiences in the form of discussion or publication in the form of writing.

However, these 8 steps are not absolutely necessary to be followed because some versions use a number of different stages but with generally the same substance. More simply, the LS stage can be carried out through a series of activities: Planning Doing-Seeing [8]. These three activities are termed as practice-oriented learning studies. These activities are described as in Figure 1.
Furthermore, Lewis stated, that LS is a complex process, supported by collaborative goal setting, careful consideration in collecting data about student learning, and agreements that provide opportunities for productive discussion about difficult issues. CB is essentially a continuous cyclical activity that has practical implications in education. The LS cycle is presented in Figure 2.

**Figure 1.** Practice-oriented learning.

**Figure 2.** Lesson study cycle.

LS cannot be separated from Kounaikenshu Japan which is a form of CPD (Continuing Professional Development) [11]. Kounaikenshu began to develop in the 1960s is a form of school-based ongoing training (school based service training) [12], where each teacher continuously conducts workshops with colleagues to improve their professional quality. Kounaikenshu emerged as an answer to various problems that arose in various schools in Japan including bullying (intimidation by friends), refusal of students to go to school, decreased performance and so on.
After much success and through various evolutions Kounaikenshu in the 90s developed into kenkyu jugyou, which when translated freely jugyou means lesson or lesson and kenkyuu means research [7]. Jugyou kenkyuu which was popularized by Prof. Manabu Sato, relinquishing the dependence of teachers and rigid curriculum, bringing teachers and students to be more active and having a broader vision, as well as providing space for the emergence of a solution of learning that is applicable. This change is the creation of a learning community in schools and opening up the broadest learning process in the classroom to be observed by anyone. Jugyou kenkyuu is a simple idea to improve teaching that is more real than just a collaboration between a teacher and another teacher to plan, teach, observe, review and report the results on applications in individual teaching. The term LS itself was first raised by Makoto Yoshida, a Japanese education expert in his doctoral dissertation at the University of Chicago, by translating jugyou kenkyuu as Lesson Study.

At first this application invited various pessimistic tones, most of the practitioners of education in America thought LS was only suitable to be applied in Japan and not suitable for the conditions in America. However, in its development, many schools and even colleges have tried to apply LS especially for science subjects / subjects such as mathematics and physics. An interesting fact is that the application of LS in America is actually more developed in higher education than at the school level. In Indonesia, LS develops through the IMSTEP (Indonesia Mathematics and Science Teacher Education Project) project, a collaborative project between three universities in Indonesia and JICA (Japan International Corporation Agency) to improve the quality of mathematics and natural science education in Indonesia [12].

3. Results and discussion
LS as an innovation will not be easy to implement without various obstacles. Support for the creation of ideal conditions becomes very important especially to convince educators that LS will provide optimal benefits for them. By taking some lessons from Japan, we hope that LS can be applied optimally in Indonesia. the application of lesson study, namely:

3.1. Education policy stability
Education policies need to be done carefully. Innovations are applied carefully through careful evaluation. With policy stability, educators can concentrate on their work and do not need to think of policies that are actually counterproductive. If there are too many policy changes, it will cause educators to not be able to focus on their responsibilities in providing knowledge to students.

3.2. Flexible curriculum
Many, this gives the opportunity for educators to have more time to give understanding to students from each material given. Textbooks do not need to be thick, so they will provide a space that requires teachers to think and develop their own material. This forces the educators to discuss with colleagues in order to develop the content of the material

3.3. Culture of self-reflection
It should be a culture for educators to always criticize themselves if they fail to carry out their responsibilities. In the modern era this culture can be developed into a positive culture, which is always reflecting on the conditions that occur. It is expected that educators always try to find the cause of failure from themselves first and fix it so that it does not recur in the future.

3.4. A culture of cooperation
Someone who is able to help his colleagues to achieve success together will be more honorable than one who has a brilliant career but reaches it alone, even though this is seen as strange by the culture that tends to develop now. This collaborative culture causes LS to be easily developed and will be accepted among education because collaboration between educators is one of the essence of LS. According to Cerbin and Cobb [9], there are 4 main reasons that motivate the use of LS which are to: 1) better
understand how students understand what is taught; 2) creating products that can be used by other educators in their group; 3) improve teaching methods; and 4) forming pedagogical knowledge based on what benefits teachers can receive as other knowledge in teaching.

Basically, LS is classically learning with several special characteristics, including: 1) Learning in LS is observed by tutors or other teachers. Teachers or tutors who make observations can come from the same institution or wider group, even some LS learning opens opportunities for teachers who come from other countries to make observations; 2) LS is planned for long-term learning and is usually collaborative in nature; 3) LS is designed to provide an understanding of the goals or vision of an educational process; 4) CB must be well documented; and 5) LS is for discussion. The most common type of LS is "within school research lesson", which in general the LS model takes place in the school. The second type is "public research lesson", this type of model is open to teachers from outside the school, whether managed by groups of teachers in regional areas or by regional or central government. Another type is LS as part of a national conference or teacher association.

3.5. Teacher professionalism

Professionalism is a quality and behavior that is characterized by a profession. The profession itself contains the meaning of the field of work which is based on the education of certain expertise. According to Mc Cully in A. Tabrani Rusyan [13] said "Profession is a vocation with professional knowledge of some departments of learning science is used in its application to the other or in practice of the art found it". From this understanding, it can be interpreted that in a work that is professional, it uses techniques and procedures that are based on an intellectual foundation, which must be deliberately learned and then directly can be enshrined for other people's problems. Professionalism is defined as quality or behavior that is characteristic of an occupational field based on expertise education (skills, vocational) certain to run it. According to Nana Sudjana in M. Uzer Usman [14], said work that is professional in nature is: "work that can only be done by those who are specially prepared for it and not work done by those who cannot find other work".

MeExplain that "professionalism is as a commitment to professional ideas and career". Professionalism has rules and commitment to provide definitions of technical scientific positions and positions that will be given to community service so that specifically the positions of the position are corrected scientifically and ethically as an affirmation of professionalism. Professionalism cannot be done on the basis of feelings, willingness, opinions, but it is really based on academic knowledge, given, combines study with work directly in integrated phases ".

Professional educators are those who have the authority to master the substance of their work professionally. Professional teachers according to Nanang Fattah are [15]: a) able to master the substance of subjects systematically, especially subject matter specifically taught and demanded to try to follow the development of the subject matter from time to time; b) understand and can apply developmental psychology so that a teacher can choose subject matter based on the level of difficulty in accordance with the development period of students being taught; and c) have the ability to develop educational programs specifically arranged according to the level of development of students to be taught. This education program is developed in accordance with the objectives of education by combining the choice of subject matter, the level of student development. It is this expertise in developing teaching programs that we can identify as a teacher's professional work that cannot be carried out by other professions. Professional educators will be able to translate their own professional capacity into their work or profession, which is to teach students. Likewise, an educator must continue to improve his competence in managing the teaching and learning process. Teachers as educators must have academic qualifications, competencies, educator certificates, physically and mentally healthy, and have the ability to realize national education goals. The basic competencies that must be possessed by teachers include pedagogic competence, personal or personality competencies, social competencies, and professional competencies obtained through professional education [16]. Suparno [17], said that this competency, related to the ability of teachers in teaching, guiding, and also giving examples of life to students. Based on research results, many of our teachers are still low in teaching competence, so in
professional education and certification of teaching skills must take precedence. Based on research results, many of our teachers are still low in teaching competence, so in professional education and certification of teaching skills must take precedence. and also set a life model for students. Based on research results, many of our teachers are still low in teaching competence, so in professional education and certification of teaching skills must take precedence.

3.6. Teacher professional development through lesson study

LS can provide a solution, because LS is a model of fostering the profession of educators through collaborative and continuous assessment of learning based on the principles of collegiality and mutual learning to build learning communities. Educators collaboratively, first analyze learning problems, both from the aspect of teaching materials and learning methods. Furthermore, collaboratively also educators look for solutions and design student-centered learning. The next step is to apply classroom learning by a teacher, while others are observers of student activities followed by post-learning discussions to reflect on it. If the principles of LS are carried out systemically and sustainably it will probably have an impact on improving the quality of education in Indonesia.

LS is one of the strategies for teacher professional development. The teacher group develops learning together, one teacher is assigned to carry out learning, the other teacher observes student learning. This process is carried out during the learning process. At the end of the activity, the teachers gather and do a question and answer about the learning conducted, revise and arrange the next learning based on the results of the discussion. LS in developing teacher professionalism, there are 8 (eight) opportunities that can be obtained if he / she is carrying out continuously. The 8 opportunities are closely related to the development of teacher professionalism [7], namely: 1) thinking carefully about learning objectives, subject matter, and fields of study; 2) review and develop the best learning that can be developed; 3) deepening knowledge about the subject matter taught; 4) think deeply about the long-term goals to be achieved relating to students; 5) design collaborative learning; 6) examine carefully the ways and processes of learning and student behavior; (7) develops powerful pedagogical knowledge with power; and (8) see the results of self-learning through students and colleagues.

Because LS can improve the professionalism of teachers, the continuous implementation of LS is believed to be able to improve everyday learning practices. Improving learning practices will lead to improving the quality of student learning processes and products. In learning practice, operational LS can be carried out through 6 (six) stages, namely: 1) forming LS groups; 2) focus on LS; 3) Planning a Research Lesson (RL); 4) learn and observe RL; 5) discuss and analyze RL; and 6) reflecting and re-planning LS.

4. Conclusion

LS is an alternative guidance for the teaching profession through collaborative and ongoing activities. The principle of collaboration will facilitate teachers to build effective and efficient learning communities, while the sustainable principle will provide opportunities for teachers to become lifelong learning communities. The ongoing implementation of LS will help teachers develop professional competence and accelerate their professionalism improvement. Indicators for enhancing teacher professionalism through the implementation of LS are the development of Learning Design and Implementation (RPP) which always requires learning innovations and assessments, plan-do-see cycles that enable teachers to develop critical and creative thinking about learning and learning.

Time for educators. By planning and using a directed approach that is easily understood by members of the CB group, the consumption of time to conduct the CB can be minimized. LS focuses on educators and learners’ learning ways, along with increasing LS activities will have implications for improving the quality of students. So measuring the success of LS is not solely based on the results of tests or examinations of students. LS is not about looking for teaching styles who are the best among group members. LS aims to find the best way to teach by collaborating with the various strengths of the educators who are members of the group. The important thing in this study lesson is the desire of each group member to develop for the better. CBs demand more concrete action than talking conceptual
problems. Discussing is actually a real example of this action if the direction of the discussion is clarified in accordance with the substance of the discussion. Documentation is one of the basic principles in lesson study group activities. Discussion and observation notes are needed, among others, to prevent repetition of the same discussion topic and record observations of students' behavior during the PBM process.

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