Teachers' hard and soft skills in innovative teaching of mathematics

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ABSTRACT: This descriptive study aims to find out high school teachers' hard and soft skills in implementing innovative character-based learning of mathematics. The subjects of the study were 17 high school mathematics teachers who deliver innovative mathematics lessons with six postgraduate students from STKIP Siliwangi in lesson study activities. Data were gathered through observation, interviews and document study of the participating teachers. In addition, tests and questionnaires were also administered to the students. The findings revealed that: 1) mathematical hard skills and soft skills of the students who learn using value and character-based innovative learning are better than those of students learning through conventional learning; 2) mathematics teachers' hard skills and soft skills are generally in the medium category; 3) teachers face some difficulties in implementing value- and character-based innovative learning; 4) there is high association (correlation) between teachers' hard skills and soft skills; and 5) further education, training, workshop, and lesson study activities are useful for improving mathematics teachers' hard and soft skills.

INTRODUCTION

In the context of national development, education serves to: 1) unify the nation; 2) equalise opportunities; and 3) develop the potential of individuals. In the face of tighter competition in an age of information, the development of cognitive, affective and psychomotor aspects [1][2], as well as the values of cultural and national character education [3], are absolute necessities in learning, including in learning mathematics. Based on the process of learning, cognitive mathematical skills reflected in mathematical thinking are the hard skills, while affective behaviour or also known as mathematical disposition, is the soft skill of mathematics.

The 2013 Indonesian Curriculum stipulates that in learning mathematics, cognitive knowledge as mathematical hard skills and affective behaviour (including cultural and character education) as a mathematical soft skill should be developed simultaneously and in balance. Hendriana and Rohaetin found in the first year of their study that teachers face difficulties in implementing various innovative learning based on character education [4]. The teachers also find that formulating tasks to suit students' mathematical hard and soft skills' indicators is challenging.

Based on these findings, the researcher conducted a study to examine the hard skills and soft skills of secondary education mathematics teachers in supporting the implementation of value- and character-based innovative mathematical learning. Teachers' hard skills in this study include their professional and pedagogical competence, while the soft skills cover their social capability and personality.

Teachers' and Students' Hard Skills and Soft Skills

Mathematics teachers' hard skills and soft skills are determined according to Permendiknas (Decree of Minister of National Education) No. 8/2009 [5], which consist of professional and pedagogical competencies (hard skills), and social competence and personality (soft skills) detailed below.

Professional competence (knowledge and comprehension) are:

- Understanding the theories of mathematics and theories of mathematical learning.
- Mastering the implementation of theories of mathematics and theories of mathematical learning.
- Mastering the selection, formulation, planning, and delivery of theories of mathematics and theories of mathematical learning.
- Mastering the principles, rules, theories, and concepts of theories of mathematics, and theories of mathematical learning in the context of learning environment.

Pedagogical competence (intellectual skills) are:

- Understanding the curriculum and developing mathematics lesson plan.
- Understanding approaches, methodologies and techniques in mathematical learning, and their application in the classroom.
- Understanding the implementation of mathematical learning.
- Understanding the evaluation system of mathematical learning and its implementation in the classroom.
- Mastering the skills to assess students' comprehension level and potentials in mathematical learning.
- Mastering the skills to conduct research in mathematical learning.

Social competence (managerial skills and attitude) are:

- Upholding the norms, values, moral, religion, ethics and professional responsibilities.
- Effective communication ability.
- Understanding the issues in mathematics education and contemporary mathematics.
- Teamwork and quick adjustment to work environment abilities.
- Mastering educative interaction between teachers, students, parents and society.
- Understanding consultative communication between mathematics education, regulators and the needs of society.
- Ability to utilise and implement information and communication technology (ICT) in mathematical learning.

Personal competence (personality and practical skills) are:

- Possess mature personality, noble character, wisdom and charisma, as well as suitability to be role model to the students.
- Understand professional rights and responsibilities as a mathematics teacher.
- Understand professional tasks and functions as a mathematics teacher.
- Understand the impact of educational innovation in developing the nation's character.

Students' hard skills analysed in the present study include critical and creative thinking ability, mathematical comprehension skills, mathematical communication skills and mathematical reasoning skills. Students' soft skills involve their independency in learning and their mathematical disposition.

Value- and Character-based Innovative Mathematical Learning

Innovative learning, according to Burhanudin, is a learning designed by the learners based on his innovative ideas, which are products of learning how to learn, to get better learning achievement [6]. He further outlines innovative learning in general, as follow:

- Students participate actively in various activities that develop their skills and comprehension, with a focus on learning by doing.
- Teachers utilise various learning aids and methods to motivate students, including environment as learning sources to create interesting, fun and suitable learning.
- Teachers organise the classroom by putting up interesting books and materials, as well as preparing a *reading corner*.
- Teachers implement cooperative and interactive learning, including group learning.
- Teachers encourage students to find their own ways to solve a problem, to express their ideas, and to participate in creating and shaping their school (learning) environment [6].

Figure 1: Students are experimenting.

In regard to character education, Sauri describes four methods of implementing character-based mathematical learning: a) providing correct understanding about character education; b) habituation; c) showing exemplary character; and d) implementing integrated mathematical learning [7]. Essentially, according to Ghozi, values cannot be taught; they can only be actively and continuously developed [3]. Recognising the values embedded in cultural and character education, as well as the ways to develop them, is the primary task of teachers in integrating cultural and character education to mathematical learning in order to simultaneously develop students' mathematical competence, mathematical disposition, and cultural and character values.

Innovative mathematical learning, designed in a value- and character-based lessons in this study, includes indirect learning, macromedia flash game, discovery learning, problem-based learning, probing prompting learning and the PQR4 learning strategy. The followings figures illustrate students' activities in innovative mathematical learning. Figure 1 shows students engaged in experimentation; pictured in Figure 2 are students involved in team-work discussion; whereas Figure 3 presents students engaged discussion with a teacher.

Figure 2: Discussion among students.

Figure 3: Discussion with a teacher.

These examples of learning activities show that in innovative learning, students who are the subject of active learning develop their own knowledge; the teacher only acts as the facilitator of the process.

Research Methodology

In the present study, six postgraduate students from the Mathematics Education Department of STKIP Siliwangi collaborated with 17 secondary school teachers to implement lesson study activities, i.e. the implementation of value- and character-based innovative mathematical learning. In order to discover and assess the professional and pedagogical competencies of the teachers, the researcher conducted observations in their classroom, as well as carried out interviews with the teachers and students involved. These activities also served as a source of data concerning teachers' difficulties. Meanwhile, to gather data on teachers' personal and social competencies, the researcher administered questionnaires to students, teachers and headmasters of the school and interviewed some of them.

The sample in this study included 17 mathematics teachers in secondary level of education (junior and senior high school). The study focused on teachers' hard skills (professional and pedagogical competencies) and soft skills (personal and social competencies).

FINDINGS AND DISCUSSION

Result of Lesson Study Activities

From the lesson of study activities performed by six postgraduate students and 17 teachers in six different schools (involving the implementation of six value- and character-based innovative mathematical learning), the following results were found as listed below.

- Mathematical hard skills acquisition and improvement in secondary school students who received value- and character-based learning was better than those in students who were treated with conventional learning. This was evident in the findings that:

  - The creative and critical thinking achievement of senior high school students who are taught with indirect learning was better than that of students who received direct learning.
  - The mathematical reasoning and communication skill of senior high school students taught with macromedia flash games improved better than those of students treated with conventional learning.
  - The mathematical reasoning and communication skills of junior high school students taught with problem-based learning improved better than those of students receiving conventional learning.
  - The mathematical communication and comprehension achievement of junior high school students taught with the discovery learning approach was better than those of students taught through conventional learning.
  - The mathematical communication and comprehension achievement of students taught with problem prompting learning was better than those of students taught through conventional learning.
  - The mathematical communication and comprehension achievement of senior high school students taught with the PQR4 learning strategy was better than those of students taught through conventional learning.

- The mathematical soft skills of secondary school students taught with value- and character-based learning were better than those of students receiving conventional learning. This is evident in the findings that:

  - The mathematical disposition of senior high school students taught with macromedia flash games was better than that of students receiving conventional learning.
  - The mathematical disposition of junior high school students taught with a discovery learning approach was better than that of students taught with conventional learning.
  - The mathematical disposition of senior high school students taught with problem prompting learning was better than that of students taught with conventional learning.
  - The learning independency of junior high school students receiving problem-based learning was better than that of students receiving conventional learning.
  - The learning independency of senior high school students taught with the PQR4 learning strategy was better than that of students receiving conventional learning.
  - Further, the learning independency of senior high school students receiving indirect learning was better than that of students receiving conventional learning.

Results of Classroom Observation and Interview

Through classroom observation of 17 teachers and interviews with headmasters, students and other teachers at the six research sites, the researcher measured teachers' hard and soft skills. Teachers' hard skills were evaluated based on their professional and pedagogical competencies, while their soft skills were assessed according to social and personal competencies. The measurement was weighted in a four-point scale, in which:

The score of 3.5 - 4 belongs to the *good* category,
The score of 2 - 3.4 belongs to the *medium* category,
The score of 1 - 1.9 belongs to the *low* category.

The status of teachers' hard skills (professional and pedagogical competencies) and soft skills (social and personal competencies) are presented in Figure 4.
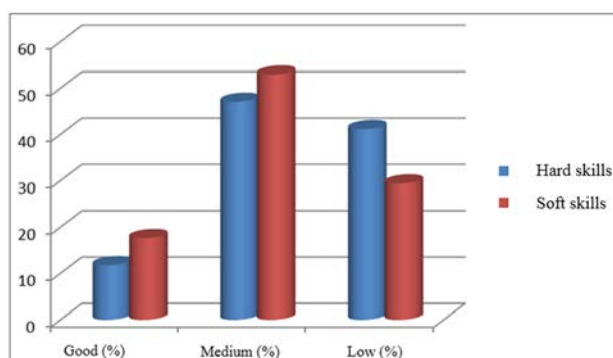

Figure 4: Description of secondary school teachers' hard and soft skills.

In Figure 1, one can see that mathematics teachers' hard and soft skills are generally in the medium level. Mathematics teachers' hard skills in the good and medium categories are lower than their soft skills in the same categories; while hard skills in the low category are higher than their soft skills in the same category. This indicates that the

professional and pedagogical competencies of mathematics teachers are lower than their social and personal competencies. Regarding teachers' professional competence, it is in line with the findings of Handayani that teacher' professional competence is generally low due to several factors, such as: 1) many teachers do not fully engage themselves in their profession; 2) not all teachers satisfy the required standard of professionalism; 3) some private universities are probably not serious enough in creating high quality teachers; and 4) the lack of motivation for self-development of some teachers [8]. Meanwhile, the findings on teachers' pedagogical competence are congruent with these of Bukhori who argues that pedagogical competence need to receive more serious consideration [9]. It is because education in Indonesia is regarded as unsuccessful by most of the society. Therefore, teachers need to possess sufficient pedagogical competence to manage the learning and to change public opinion.

To see the correlation between teachers' hard skills and soft skills, the data is presented in table form, as follows:

Table 1: Correlation between teachers' hard and soft skills.

Hard skills	Soft skills			Total
	Good	Medium	Low	
Good	1	1	0	2
Medium	2	4	2	8
Low	0	4	3	7
Total	3	9	5	17

Using SPSS software, it was found that sig = 0.000 is lower than α = 0.05; which indicates that H_0 (no correlation between hard and soft skills) is rejected. Findings indicate that there is significant association (correlation) between teachers' hard skills and soft skills. It was also found that C is 0.734; with C_{max} of 0.82 (or C = 0.89 C_{max}), which indicates that the association between teachers' hard skills and soft skills is in the high category (good). It implies that teachers with good hard skills tend to have good soft skills, while teachers with low hard skills tend to possess low soft skills. Therefore, it is necessary to improve teachers' hard and soft skills optimally; particularly considering the high demand put on them.

Hamid notes that teachers are required to be more creative and innovative in delivering lessons [10]. Therefore, teachers have to be trained in developing lessons based on the competencies that students need to acquire. They also need to be trained in integrating various skills (hard and soft skills) in each lesson. It means that teachers have to continuously develop themselves to deliver a learning (lesson), which could accommodate soft skills and hard skills as a unit of educational success.

Based on the interviews with teachers, the following difficulties were found in the implementation of various value- and character-based innovative learnings:

- There are too many students in a classroom and they are too heterogeneous. This makes it difficult for teachers to implement innovative learning, which often involves individual guidance to students with difficulties in adjusting themselves to innovative learning process.
- The amount of material in a semester tends to be too much. This makes it difficult for teachers to implement innovative learning that needs longer time to complete a single learning cycle.
- The number of responsibilities and tasks that teachers have to fulfil makes it difficult for them to find time to get the latest information or to participate in innovative learning implementation training.
- The frequently changing curriculum often results in teachers' confusion, particularly concerning the implementation of learning to satisfy the demand of the curriculum.
- Research conducted by university students is often incidental or only for academic purposes. These pieces of research are seldom socialised to teachers as practitioners in the field.

Therefore, as suggested by Mulyasa [11], Yamin [12] and Sagala [13], there are several things that teachers can do to improve their competencies:

- Further study (education), in which teachers are expected to improve their knowledge and insight in accordance with the latest developments in their respective field by enrolling in a higher level of education as required by the government.
- Teachers' participation in seminars, training, workshops or courses to improve their teaching skills.
- Teachers' active participation in discussions with their peers through subject teachers' discussion (*Musyawarah Guru Mata Pelajaran*/MGMP) in which, in addition to following the latest development of their respective field, they can share ideas and solutions to problems and difficulties they face in daily teaching activities.
- Following the latest information in mass media (printed and electronic) and academic journals to update their knowledge.
- Active supervision and facilitation from headmasters or school supervisors in programmes that can improve teachers' creativity and welfare.

CONCLUSION AND RECOMMENDATIONS

Based on the findings and discussion, the following conclusions can be drawn:

- The mathematical hard skills and soft skills of the students who learn using value- and character-based innovative learning are better than that of students learning through conventional learning.
- The mathematical hard skills acquisition and improvement in secondary school students who received value- and character-based learning is better than those in students who are taught through conventional learning.
- The mathematical soft skills of secondary school students taught with value- and character-based learning are better than those of students receiving conventional learning. Mathematics teachers' hard skills and soft skills are generally in medium category.
- There is high association (correlation) between teachers' hard skills and soft skills. This implies that teachers with good hard skills tend to have good soft skills, while teachers with low hard skills tend to possess low soft skills. Teachers face some difficulties in implementing value- and character-based innovative learning.

Based on the results of the study, the author makes the following recommendations:

- It is important to find appropriate and effective ways to improve students' and teachers' hard and soft skills in mathematical learning to support the implementation of value- and character-based innovative learning.
- Mathematics lessons at schools should be delivered through innovative learning, which allows for students' exploration of mathematical knowledge and comprehension and provides opportunities for students to develop their knowledge independently.
- To ensure that students' hard and soft skills develop in balance, the values of character education need to be integrated in the context of students' daily experience.
- Teachers should be given opportunities to participate in training and workshops to improve their knowledge and insights concerning innovative learning, as well as to improve their skills in integrating character education into it.
- Lesson study activities conducted by mathematics teachers are necessary in order to develop and improve the four sets of competencies that teachers are required to possess.

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