International Journal of Learning, Teaching and Educational Research
Vol. 17, No. 11, pp. 32-47, November 2018
https://doi.org/10.26803/ijlter.17.11.3

Competency-Oriented Teaching of Primary School Math Problems in Vietnam

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Abstract. In Vietnam today, competency-oriented teaching is a mainstream trend. Students are not only equipped with knowledge, but also trained and developed their capacity to meet the needs of the society. Teaching in particular and teaching mathematics in elementary schools is not out of this necessary trend. Our article gives some new insights of competency as well as how to teach and develop mathematical competency through a primary school math problem. The article also gives the delivery on teaching a problem according to competency.

Keywords: competency, primary school mathematics, concept.

1. Introduction

Today, due to the rapid development of science and technology, the way of learning has changed a lot. Instead of learning the contents of knowledge, developing thinking, we now learn to develop competency. Teaching oriented competency has many strong points. Students feel more confident. They can communicate with other people friendly and easily. Especially, they adapt the need of work. Teaching oriented competency helps students overcome the difficulties in the life.

There are many researches on competency but mainly on theoretical basis. However, what is the way to demonstrate competency? How do we solve competency-oriented specific math problems? These things must be attentive. We need a concrete illustration.

In Vietnam, our education is changing according to the competency-oriented teaching. This problem is interested by many teachers and researchers. That 's reason why we refer to these issues in the article.

2. Research content

2.1. The concept of competency

Competency is a complex concept and has not come together. At present, there are hundreds of different definitions of competency. The nature of competency is expressed in four characteristics. First, competency is the integration or aggregation of many elements; Second, competency is revealed through activities; Third, the disclosure of competency must be effective, and the fourth is the context, the time of execution, or the area of competency.

To define a scientific concept, according to logic, there are two parts. The first part addresses the scientific concept of a certain category to distinguish that concept from another. For example, the parallelogram is a quadrilateral ... (Hoang, 2015)

The second part is the description of the form, the structure, the function, the origin,... of the concept to distinguish it from other concepts of the same category. For example, the parallelogram is a quadrilateral with two pairs of opposite sides in parallel. (Hoang, 2015)

The conference documents of the new general education curriculum of the Ministry of Education and Training of Vietnam defines competency as the mobilization of the general knowledge, skills and other personalities such as interest, belief, will ... to perform a certain type of work in a given context. (Ministry of Education and Training of Vietnam, 2018)

This definition has the limitation that it does not specify the performance of the job. The performance must be effective, that is competency.

The Vietnamese Encyclopedia (2018) reported that the competency is a characteristic of an individual who demonstrates the proficiency - i.e., it can be done in a certain way or in a proficient way - of some activities.

This definition refers to the skills of the individual. However, we say that competency is an individual's trait, this way of saying does not seem to be accurate. It is more accurate to say that the competency is of the individual or many people. Many people can work together to accomplish a good job. It cannot be attributed to an individual, but to a group of people who perform it.

The Vietnamese dictionary says that competency is the psychological and physiological qualities that give people the ability to do something with high quality. (Hoang et al, 1988), This definition has two limitations, that is, the competency is defined through ability and not to refer to the context or area in which it is expressed. Competency must be performed in a specific context, time and area. In a context, an individual's or a group's performance is competency, but in another context, it is not. Let's take the calculation example: 1 + 2 + 3 + ... + 99 + 100 by adding together 1 + 2 = 3; 3 + 3 = 6; 6 + 4 = 10; ... from the nineteenth century back, this is not the calculation competency because this activity is not effective, easy to make mistakes, but in this century it is calculation competency and it is indispensable in information technology. The cumulative addition is an indispensable skill for anyone involved in programming.

Hoang (2015) reported that according to Tran and Nguyen, competency is the synthesis of unique attributes of individuals in accordance with the specific requirements of a certain activity, to ensure the completion of good results in the field.

Hoang (2015) reported that according to Dang, competency is an individual's attribute that allows an individual to successfully perform certain activities, achieving desired results under specific conditions.

Hoang (2015) reported that the term attribute does not express the social nature of competency because the attribute in Vietnamese is understood as "the inherent characteristic of a thing, where things exist, and through which human beings perceive things, distinguish one from another. For example, color is the property of all things. In the meantime, competency can be developed by aptitude (the physiological characteristics of human beings, the central nervous system), but not the innate, but the result of the social development (social life, education and training, personal activities).

Competency is a term that is used both scientifically and in everyday language. Underlying a large variety of meanings, it is possibility to discern a small semantic core that is captured by the terms “ability”, “aptitude”, “capability”, “competency”, “effectiveness” and skill. Competency can be attributed to individuals, social groups or institutions when they possess or acquire the conditions for achieving specific developmental goals and meeting important demands presented by the external environment. Because schools must educate, teach, and prepare each student for future life tasks, the focus in this report will be on competency as an individual attribute, rather than on the competency of a social group or institution. (Weinert, 1999)

Competency “is the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served” (Epstein & Hundert, 2002).

In contrast to competency, with its plural form, competencies, is a narrower, more atomistic concept to label particular abilities (Smith, 1996). In other words, a competency is a single skill or ability, which can be derived from functional job analysis.

The applied knowledge, manifestation of skills that produce success, and observable behaviors related to attitudes are necessary and sufficient conditions to competencies (Schoonover, 2003).

Kennedy, Hyland & Ryan, (2009) reported that according to Adam, the relationship between learning outcomes and competency is a complex area – the subject of some debate and no little confusion.

Competency can be likened to the integral mobilization of a diversity of internal resources (‘knowledge’, ‘technical skills’, and ‘social/interpersonal skills’) and external (material and human) to solve a given complex situation. (Zineb, Soumia, Souad & Karim, 2017)

From the above viewpoints of competency, we define the definition of competency as follows: competency is the sum of all elements of psychological and physiological quality and effective actions, ... of an individuals or many people in a specific context of space, time and area for some work to do.

Thus, our definition of competency does not separate action from psychological and physiological qualities ... which must be "merged" into one. The united group helps to do the work effectively in a specific context of space, time and area. We call it competency.

2.2. Mathematical competencies

There are 8 mathematical competencies (Niss, 2002) as follows:

2.2.1. Thinking mathematically

Such as

- *Posing questions* that are characteristic of mathematics and *knowing the kinds* of answers (not necessarily the answers themselves or how to obtain them) that mathematics may offer;
- understanding and handling the *scope* and *limitations* of a given *concept;*
- *extending* the scope of a *concept* by *abstracting* some of its properties; *generalising results* to larger classes of objects;
- *distinguishing* between different *kinds of mathematical statements* (including conditioned assertions ('if-then') quantifier laden statements, assumptions, definitions, theorem, conjectures, cases).

2.2.2. Posing and solving mathematical problems

Such as

- *identifying, posing* and *specifying* different kinds of mathematical *problems* – pure or applied, open-ended or closed;

• *solving* different kinds of mathematical problems (pure or applied, open-ended or closed), whether posed by others or by oneself, and, if appropriate, in different ways.

2.2.3. Modelling mathematically

Such as

• *analysing* foundations and properties of *existing models*, including assessing their range and validity;

• *decoding* existing models, i.e. translating and interpreting model elements in terms of the 'reality' modelled.

• *performing active modelling* in a given context.

- structuring the field;

- mathematising;

- working with (in) the model, including solving the problems it gives rise to;

- validating the model, internally and externally;

- analysing and criticising the model, in itself and vis-à-vis possible alternatives;

- communicating about the model and its results;

- monitoring and controlling the entire modelling process.

2.2.4. Reasoning mathematically

Such as

• *following* and *assessing chains of arguments*, put forward by other;

• *knowing* what a mathematical *proof is* (not), and how it differs from other kinds of mathematical reasoning, for example, heuristics;

• *uncovering* the *basic ideas* in a given line of argument (especially a proof), including distinguishing main lines from details, ideas from technicalities;

• *devising* formal and informal mathematical *arguments*, and *transforming* heuristics arguments to valid proofs, i.e. *proving statements.*

2.2.5. Representing mathematics entities

Such as

• *understanding* and *utilising* (decoding, intepreting, distinguishing between) different sorts of representations of mathematical object, phenomena and situations;

• understanding and utilising the *relations between different representations* of the same entity, including knowing about their realative strengths and limitations;

- *choosing* and *switching* between representations.

2.2.6. Handling mathematical symbols and formalisms

Such as

- *decoding* and *interpreting symbolic and formal* mathematical *language*, and understanding *its relations to natural language*;
- understanding the *nature* and *rules* of *formal mathematical systems* (both syntax and semantics);
- *translating* from *natural language* to *formal/symbolic language*;
- *handling* and manipulating statements and *expressions* containing *symbols* and *formulae.*

2.2.7. Communicating in, with, and about mathematics

Such as

- *understanding others'* written, visual or oral 'texts' in a variety of linguistics registers, about matters having a mathematical content;
- *expressing oneself*, at different levels of theoretical and technical precision, in oral, visual or written form, about such matters.

2.2.8. Making use of aids and tools (include IT)

- *knowing* the *existence* and *properties* of various tools and aids for mathematical activity, and their range and limitations;
- to use such aids and tools reflectively.

2.3. An illustrative example of competency-oriented mathematics teaching in primary schools in Vietnam

Example 1

There are 36 chickens and dogs in the yard. 100 legs are counted. How many chickens and dogs are there? (Tran, 2008)

Solution 1

Competency of mathematics includes the following.

- *Thinking mathematically*

- What is the question of the math problem? (The number of chickens and the number of dogs).

- How to find the number of chickens and dogs? (We use temporary hypothesis, assuming that the 36 animals are dogs.)

- If the 36 animals were dogs, then what would the number of legs be?($36 \times 4 = 144$ (legs)).

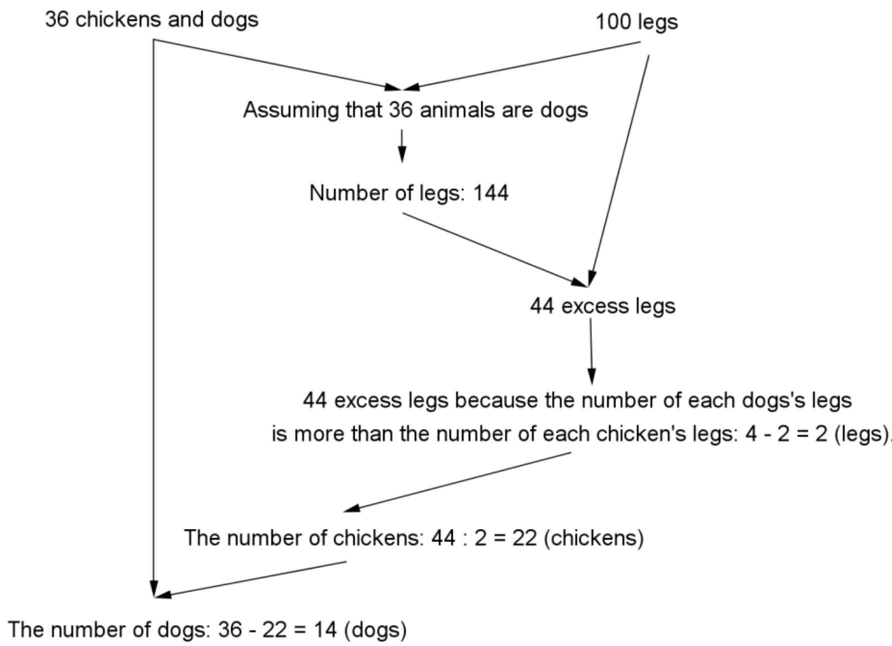
- How many excess legs are there? (144 - 100 = 44 (legs)).

- Why are there excess legs? (Because the number of legs per dog is more than the number of legs per chicken: 4 - 2 = 2 (legs)).

- 44 excess legs because each dog has two more legs than each chicken. So how many chickens are there? (44: 2 = 22 (chickens)).

- What is the number of dogs? (36 - 22 = 14 (dogs)).

- *Representing mathematical entities*



- *Posing and solving mathematical problems*

Assuming the 36 animals are dogs, the number of legs would be: 4 x 36 = 144 (legs).

The number of excess legs is: 144 - 100 = 44 (legs).

This is because the number of each dog's legs is more than the number of each chicken's legs: 4 - 2 = 2 (legs).

So the number of chickens is 44 : 2 = 22 (chickens).

The number of dogs: 36 - 22 = 14 (dogs).

Answer: 22 chickens; 14 dogs.

• *Communicating in, with, and about mathematics*

The writing style in the solution is clear, strict and accurate. It is not vague and difficult to understand.

• *Handling mathematical symbols and formalism*

Use these symbols $+, -, \times, :$ proficiently, without any confusion.

• *Making use of aids and tools (IT included)*

Use a handheld calculator to check the solution. With 22 chickens and 14 dogs, the total number of legs is: $22 \times 2 + 14 \times 4 = 44 + 56 = 100$ (legs)

So the solution of the math problem is correct.

• *Reasoning mathematically*

Instead of assuming the 36 animals are dogs, we assume that the 36 animals are chickens. We can refer to the solution below.

Solution 2

• *Thinking mathematically*

- What is the question of the math problem? (The number of chickens and the number of dogs).

- How to find the number of chickens and dogs? (We use temporary hypothesis, assuming that the 36 animals are chickens.)

- If the 36 animals were chickens, then what would the number of legs be?($36 \times 2 = 72$ (legs)).

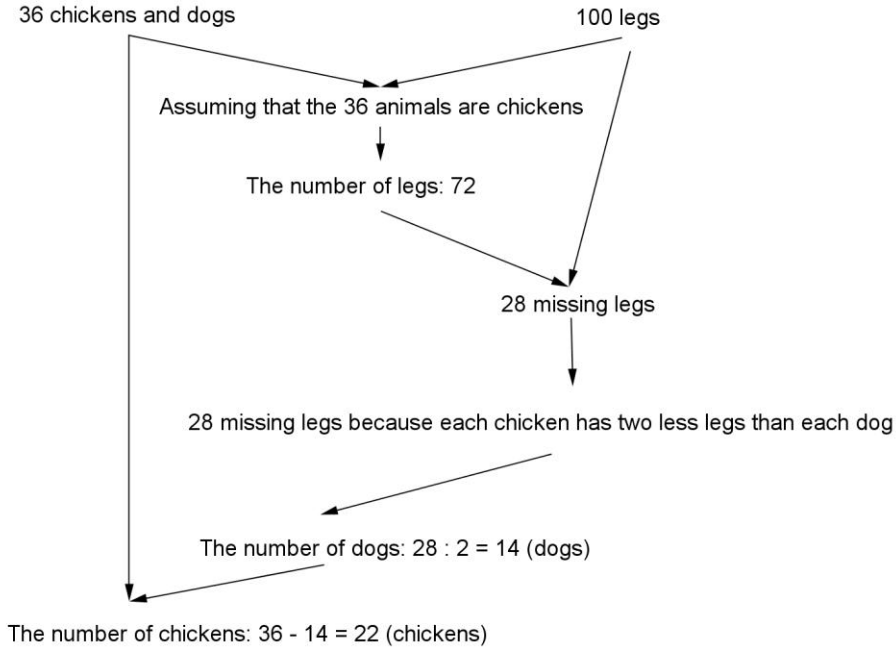
- How many missing legs are there? (100 – 72 = 28 (legs)).

- Why are there missing legs? (Because the number of legs per chicken is less than the number of legs per dog: 4 - 2 = 2 (legs)).

- 28 missing legs because each chicken has two less legs than each dog. So how many dogs are there? (28 : 2 = 14 (dogs)).

- What is the number of chickens? (36 – 14 = 22 (chickens)).

- *Representing mathematical entities*



- *Posing and solving mathematical problems*

Assuming the 36 animals are chickens, the number of legs would be: $2 \times 36 = 72$ (legs).

The number of missing legs is: $100 - 72 = 28$ (legs).

This is because the number of each chicken's legs is less than the number of each dog's legs: 4 - 2 = 2 (legs).

So the number of dogs is: $28 : 2 = 14$ (dogs)

The number of chickens: $36 - 14 = 22$ (chickens).

Answer: 22 chickens; 14 dogs.

- *Communicating in, with, and about mathematics*

The writing style in the solution is clear, strict and accurate. It is not vague and difficult to understand.

- *Handling mathematical symbols and formalism*

Use these symbols $+, -, \times, :$ proficiently, without any confusion.

- *Making use of aids and tools (IT included)*

Use a handheld calculator to check the solution. With 22 chickens and 14 dogs, the total number of legs is: $22 \times 2 + 14 \times 4 = 44 + 56 = 100$ (legs)

So the solution of the math problem is correct.

• *Reasoning mathematically*

Instead of assuming the 36 animals are dogs or chickens, we assume that each of the 36 animals has one more head. We can refer to the solution below.

Solution 3

• *Thinking mathematically*

- What is the question of the math problem? (The number of chickens and the number of dogs).

- How to find the number of chickens and dogs? (We use temporary hypothesis, assuming that each of the dogs and the chickens has one more head.)

- If each of the 36 animals has one more head, then what would the number of heads be?($36 \times 2 = 72$ (heads)).

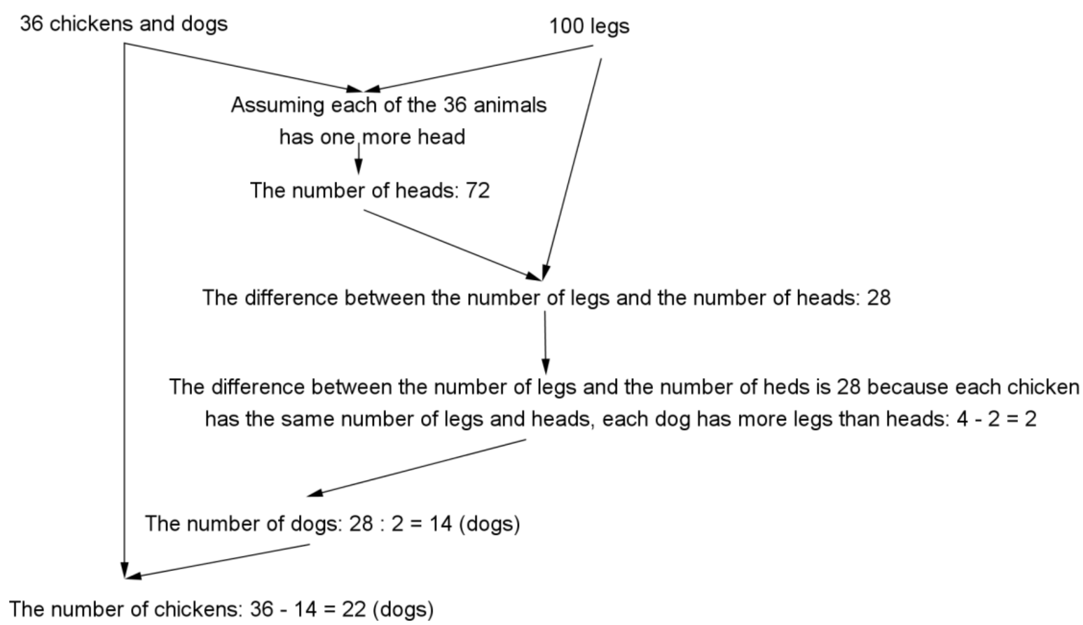
- What is the difference between the number of legs and the number of heads? (100 – 72 = 28).

- Why are there more legs than heads? (Because each chicken has the same number of heads and legs, each dog has more legs than heads: 4 – 2 = 2.)

- What is the number of dogs? (28 : 2 = 14 (dogs))

- What is the number of chickens? (36 – 14 = 22 (chickens)).

• *Representing mathematical entities*



• *Posing and solving mathematical problems*

Assuming that each of the animals has one more head. Then each of the animals has two heads, the number of heads would be: $2 \times 36 = 72$ (heads).

Then each of the chickens has two heads and two legs, each of the dogs has two heads and four legs. The difference between the number of legs and the number of heads is: $100 - 72 = 28$.

Each chicken has the same number of heads and legs, each dog has more legs than heads: 4 – 2 = 2.

So the number of dogs is: $28 : 2 = 14$ (dogs)

The number of chickens: $36 - 14 = 22$ (chickens).

Answer: 22 chickens; 14 dogs.

• *Communicating in, with, and about mathematics*

The writing style in the solution is clear, strict and accurate. It is not vague and difficult to understand.

• *Handling mathematical symbols and formalism*

Use these symbols $+, -, \times, :$ proficiently, without any confusion.

• *Making use of aids and tools (IT included)*

Use a handheld calculator to check the solution. With 22 chickens and 14 dogs, the total number of legs is: $22 \times 2 + 14 \times 4 = 44 + 56 = 100$ (legs)

So the solution of the math problem is correct.

• *Reasoning mathematically*

Instead of assuming each of the 36 animals has one more head, we assume that each of the 36 animals has three more heads. We can refer to the solution below.

Solution 4

• *Thinking mathematically*

- What is the question of the math problem? (The number of chickens and the number of dogs).

- How to find the number of chickens and dogs? (We use temporary hypothesis, assuming that each of the dogs and the chickens has three more heads.)

- If each of the 36 animals has three more heads, then what would the number of heads be?($36 \times 4 = 144$ (heads)).

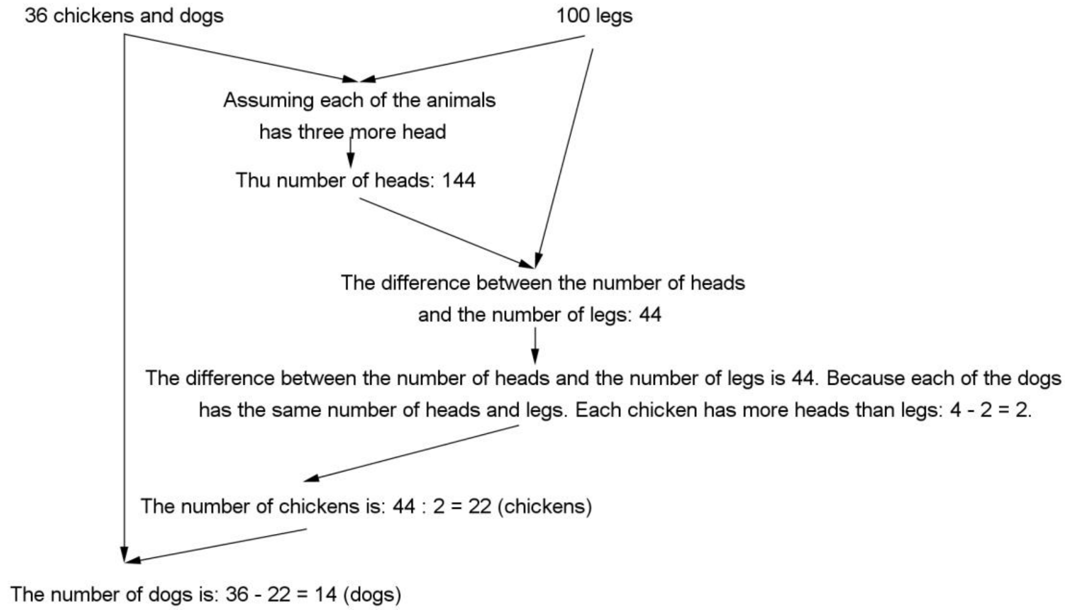
- What is the difference between the number of heads and the number of legs? (144 – 100 = 44).

- Why are there more heads than legs? (Because each dog has the same number of heads and legs, each chicken has more heads than legs: 4 – 2 = 2.)

- What is the number of chickens? (44 : 2 = 22 (chickens)).

- What is the number of dogs? (36 – 22 = 14 (dogs))

- *Representing mathematical entities*



- *Posing and solving mathematical problems*

Assuming that each of the animals has three more heads. Then each of the animals has four heads and the number of heads would be: $4 \times 36 = 144$ (heads).

Then each of the chickens has four heads and two legs, each of the dogs has four heads and four legs. The difference between the number of heads and the number of legs is: $144 - 100 = 44$.

Each of the dogs has the same number of heads and legs, each of the chickens has more heads than legs: 4 – 2 = 2.

So the number of chickens is: $36 - 14 = 22$ (chickens).

The number of dogs is: $28 : 2 = 14$ (dogs)

Answer: 22 chickens; 14 dogs.

- *Communicating in, with, and about mathematics*

The writing style in the solution is clear, strict and accurate. It is not vague and difficult to understand.

- *Handling mathematical symbols and formalism*

Use these symbols $+, -, \times, :$ proficiently, without any confusion.

- *Making use of aids and tools (IT included)*

Use a handheld calculator to check the solution. With 22 chickens and 14 dogs, the total number of legs is: $22 \times 2 + 14 \times 4 = 44 + 56 = 100$ (legs)

So the solution of the math problem is correct.

• *Reasoning mathematically*

Instead of assuming each of the 36 animals has three more heads, we assume that each of the 36 animals has half of the legs missing. We can refer to the solution below.

Solution 5

• *Thinking mathematically*

- What is the question of the math problem? (The number of chickens and the number of dogs).

- How to find the number of chickens and dogs? (We use temporary hypothesis, assuming that each of the dogs and the chickens has half of the legs missing.)

- If each of the 36 animals has half of the legs missing, then what would the number of legs be?($100 : 2 = 50$ (legs)).

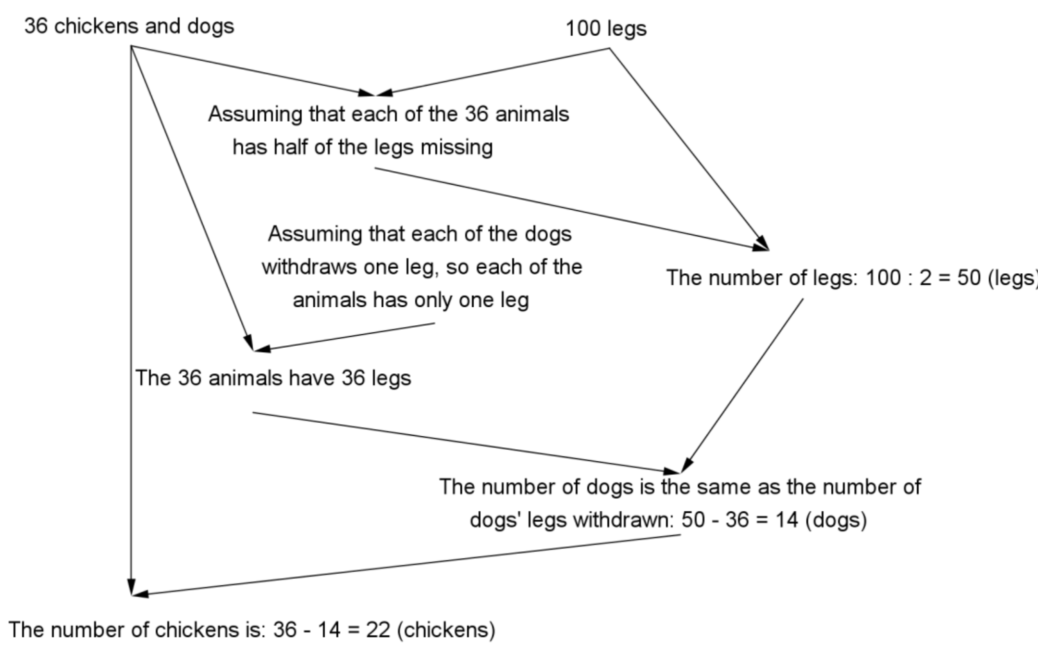
- Now we assume that each of the dogs withdraws one leg, so each of the dogs now has only one leg. Then how many legs does the 36 animals have? (36 legs).

- What is the number of the dog's legs that is withdrawn? (50 – 36 = 14 (legs)).

- Each of the dogs has one leg withdrawn, so how many dogs are there? (14 (dogs)).

- What is the number of chickens? (36 – 14 = 22 (chickens)).

• *Representing mathematical entities*



• Posing and solving mathematical problems

Assuming that each of the animals has half of the legs missing. Then each of the dogs has two legs and each of the chickens has one leg. The total number of legs is only half, that is: 100 : 2 = 50 (legs).

Now we assume that each of the dogs withdraws one leg, so each of the animals has only one leg, then the 36 animals have 36 legs. Then the number of legs withdrawn is: $50-36=14$ (legs). Because each of the dogs withdraws one leg, there are 14 dogs. So the number of chickens is: $36-14=22$ (chickens).

Answer: 22 chickens; 14 dogs.

• *Communicating in, with, and about mathematics*

The writing style in the solution is clear, strict and accurate. It is not vague and difficult to understand.

• *Handling mathematical symbols and formalism*

Use these symbols $+, -, \times, :$ proficiently, without any confusion.

• *Making use of aids and tools (IT included)*

Use a handheld calculator to check the solution. With 22 chickens and 14 dogs, the total number of legs is: $22\times 2+14\times 4=44+56=100$ (legs)

So the solution of the math problem is correct.

3. Results

We distributed questionnaires to 135 primary school teachers in Ho Chi Minh City to investigate competency-oriented teaching. Data show that 91 teachers (67.40%) thought that it is very necessary; 33 teachers (24.44%) said it is necessary; 11 teachers (8.16%) thought that it is not yet necessary; No teacher thinks that it is unnecessary. The survey shows the positive response of teachers towards competency-oriented teaching in primary schools.

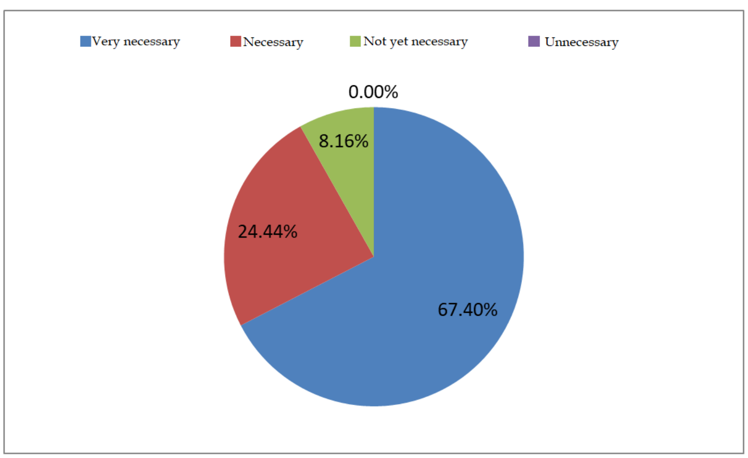


Figure 1: The attitude of primary school teachers about competency-oriented teaching

We also distributed a survey questionnaire to 257 senior primary school students on the application of Mogen Niss 's eight mathematical competencies in teaching elementary mathematics. The results are as follows

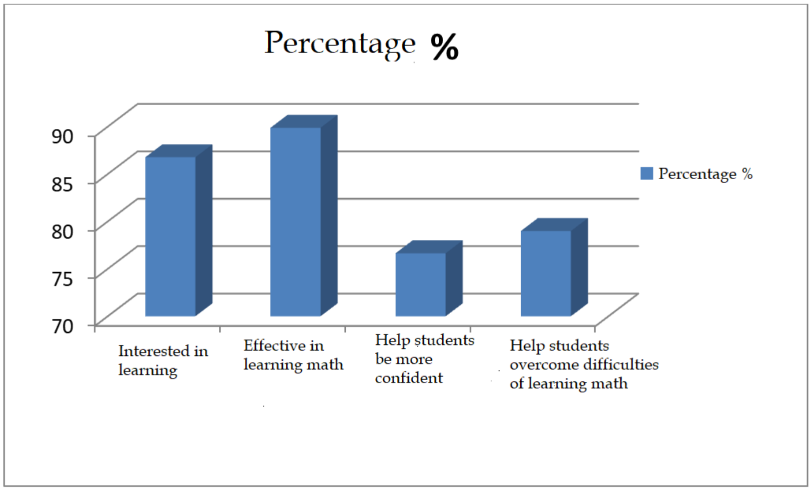


Figure 2: The effect of competency-oriented teaching

Figure 2 shows the effect of competency-oriented teaching. There were 223 students who were more interested in learning (86.77%), 231 students said that Mogen Niss 's 8 kinds of competencies increased the efficiency in learning mathematics (89.88%) and 197 students said that it helped them be more confident (76.65%), and 203 students thought that competency-oriented teaching helped them overcome the difficulties of learning.

4. Conclusion

From example 1, we realize that competency-oriented teaching in primary schools is an active one. Students develop their thinking, reasoning ability, use of formulas, symbols, mathematical performance and so on. Competency-oriented teaching of primary school math problems helps students be more self-confident, more interested in learning. However, this is an entirely new way of teaching, so it is important to have in-depth research, especially for the application of competency-oriented teaching.

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