Science Hands-on Activity in Learning Task

Josef Trna

Masaryk University, Faculty of Education,

Brno, Czech Republic

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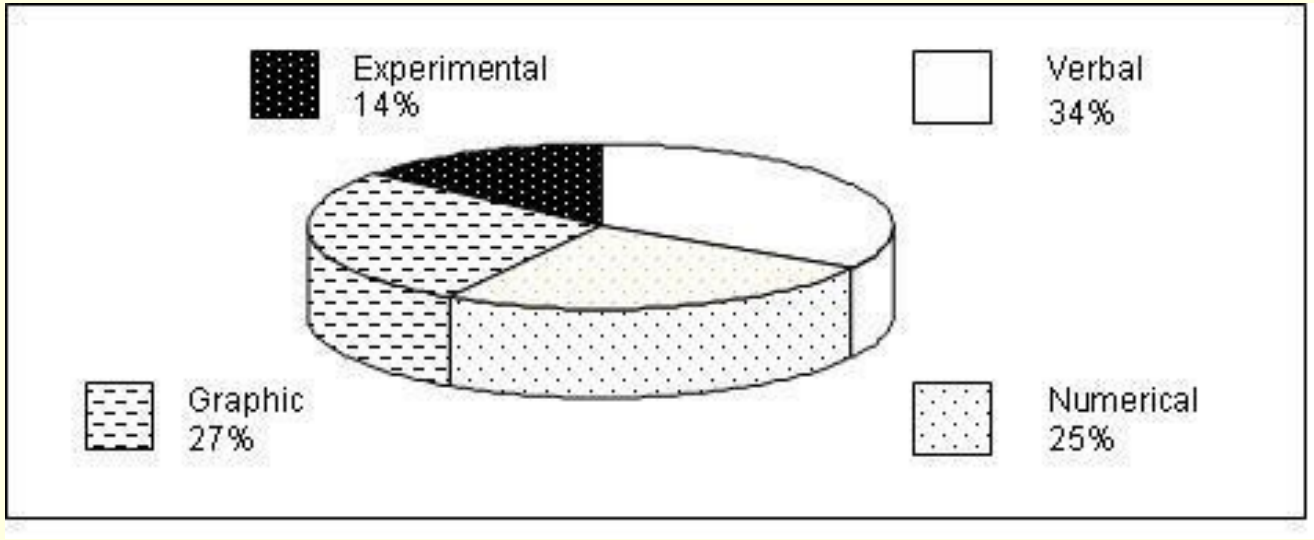
1. Introduction

- The **learning task** is a specific requirement set to students during learning/teaching. Learning tasks fulfil various functions, primarily based in the teaching phase (motivation, exposition, fixation, diagnostics and application).
- One of the main science educational objectives is creation and development of skills necessary for **problem solution**. "…without problems, without tasks, neither skills nor knowledge can be acquired" (Talyzinova).
- **Results of our research** into physics education in lower secondary schools with use of video-study:
  - teachers solve the learning tasks most frequently in interactions with students,
  - most of the learning tasks require verbal solution
  - **experimental learning tasks are rare**:

1. Introduction



Frequency of types of learning tasks (form of setting and solution)

2. Learning tasks based on hands-on activities

Learning tasks sorting criteria: educational objectives, difficultness of cognitive operations needed for task solution, level of calculations use during task solution, form of task setting and solution and especially teaching phases:

1. **educational objectives:** Hands-on activity serve as an educational objective or tool for acquirement of other educational objectives.
2. **difficultness of cognitive operations needed for learning task solution (Tollingerova)**:

- tasks demanding memory reproduction of knowledge when students use memory operations,
- tasks demanding simple mental operations with knowledge so as analysis, synthesis, comparison, categorization,
- tasks demanding complicated mental operations with knowledge so as induction, deduction, interpretation, transformation, verification,
- tasks demanding knowledge interpretation when students interpret not only the results of their own solution but also its progress, conditions and phases,
- tasks demanding creative thinking based on the previous operations, ability to combine these operations into wider complexes and come to new solutions.

2. Learning tasks based on hands-on activities

3. **level of calculations during task solution**. Hands-on activities belong mainly to the group of the qualitative learning tasks demanding a minimum of calculations. Appropriately connected with measurements and ICT, they can also be a part of the group of the quantitative learning task.
4. **form of setting and solution,** learning tasks can be classified as verbal, numerical, graphic, experimental, etc. Hands-on activities are primarily the part of the experimental learning tasks.
5. **teaching phase**, learning tasks can be classified as motivational, expositional, fixation, diagnostics and application. Hands-on activities can occur in all these groups of learning tasks but they play the most important motivational role in the motivational tasks.

Hands-on activities can be included in various types of learning tasks and they can play various roles.

We focus especially on **motivational effectiveness of hands-on activities in learning tasks:**

3. Motivation of hands-on activities

- Hands-on activities are **strongly motivational** activities.
- Students are motivated mainly by the fact that hands-on activities are **incentives exciting** students' **cognitive needs**:
  - problem solution
  - senses and muscular activity
  - modelling of natural phenomena
- Hands-on activities are **motivational education techniques**.
- An evidence of motivational effectiveness of hands-on experiments is their commercial use in form of **toys**: yo-yo, click-clack, wooden toys.

4. Motivational learning tasks based on hands-on activities

- According to classification of learning tasks based on hands-on activities, there is a **need to form these learning tasks** for their **application** during **teaching**.

- Students can be more **motivated** by **learning tasks** based on **hands-on activities**.

- We use our **applied research** to **form** motivational **learning tasks** based on **hands-on activities**:

4.1 Problem learning tasks

- The **problem based teaching** is the significant innovation of science education.
- **Motivational effectiveness** of problem learning tasks based on hands-on experiments results from **increasing students' cognitive needs** and their consequent **satisfying** by way of **students' active cognitive working.**
- **Psychological base** of increasing cognitive needs is "**perception and conceptual conflict**". This conflict becomes an incentive which causes strong motivation and thus students become active which heads towards conflict elimination and satisfaction of the need.
- An induction of that conflict has several variants:
  - **surprise**
  - **paradox**
  - **doubt**
  - **uncertainty**
  - **difficulty**

4.1 Problem learning tasks

Problem cylinder

- *We glue a coin on the base of a polystyrene cylinder. The coin has the same diameter as the cylinder. Height of the polystyrene cylinder will be adapted so that only the coin extends from the surface of the water. We turn the cylinder coin down and place it in the water again. How deep will the cylinder with the coin dip?*

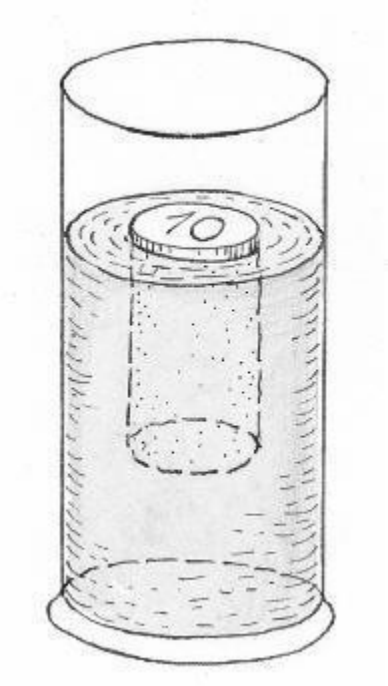
  (a) the height of an extending polystyrene is the same as the height of the coin

  (b) polystyrene will not extend from the surface since the coin pulls it to the bottom

  (c) the higher part of polystyrene than the coin will extend from the surface

- ***Correct learning task solution:*** *(a). This is about Archimedes' principle application. Weight of the cylinder does not change during turning and therefore buoyant force and volume of the sunken part of the cylinder will be the same.*

4.1 Problem learning tasks



Problem cylinder

4.2 Play learning tasks

- We define a **toy** as an **object** which **displays a feature** that is **remarkably emphasized** (elasticity, colour, distinctive behaviour etc.).
- The toy in the role of hands-on activity **stimulates the needs** to have **sense** and **muscle activities**.
- The **relaxation function** of the play is also remarkable. There are many toys manufactured commercially but students can create their own.
- We can form the play learning task based on hands-on activity and apply it in education:

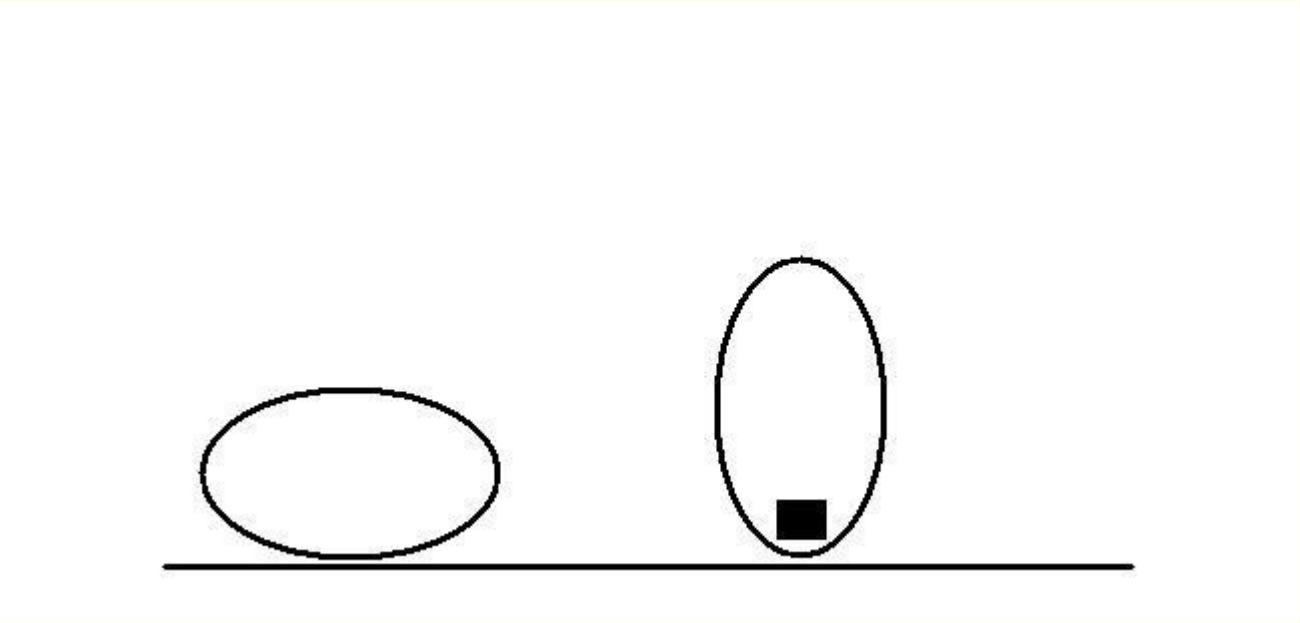
4.2 Play learning tasks

Balance:

- *The objects with a lower centre of mass do not capsize. It is recommended to use the commercial toys, oval covers or polystyrene eggs. Explain the base of the demonstrated phenomenon.*

- ***Correct learning task solution:*** *The phenomenon to understand is the balance of the objects. The centre of gravity of the object is so low that it cannot be overturned.*

4.2 Play learning tasks



Balance

4.3 Modification learning tasks

- Strong **motivation** and support of **creativity** development is brought by learning tasks which contain **creation of hands-on activities modifications.**

- Students are familiarized with a hands-on experiment and their learning task is to create similar hands-on experiment or, on the contrary, an experiment with additional physics phenomenon.

- These learning tasks are appropriate especially for **gifted students**:

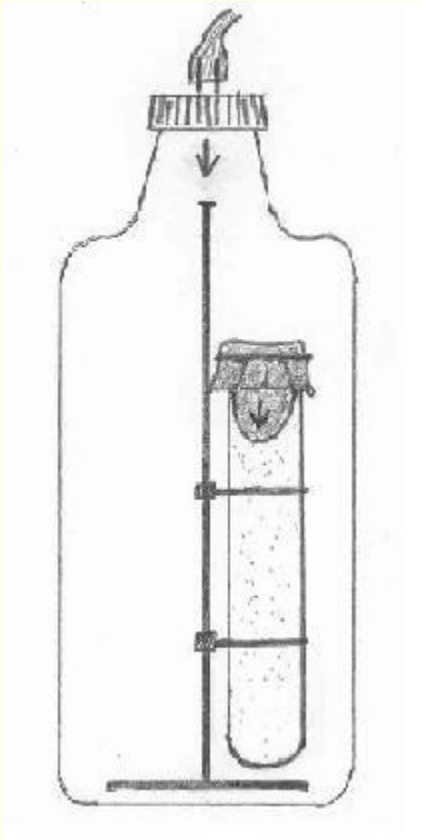
4.3 Modification learning tasks

Underpressure and overpressure:

- *Behaviour of an apparatus in an underpressure chamber is often demonstrated. An experiment with membrane flex in an underpressure container is well-known. Make an apparatus for demonstration of the inverse phenomenon in an overpressure chamber. How does this phenomenon appear on human body?*

- ***Correct learning task solution:*** *Test tube covered by rubber membrane arches by overpressure in the plastic bottle. The rubber membrane simulates behaviour of ear-drum during swimming, bathing and diving. Water in ear canal pushes on ear-drum at this time. The result is deflection of the ear-drum.*

4.3 Modification learning tasks



Overpressure

5. Conclusions

- Learning tasks based on **hands-on activities** are an important part of physics and science education.
- They are a source of **significant motivation** because they excite and satisfy primarily students' **cognitive needs**.
- **Learning tasks sorting** should be done according to educational objectives, difficultness of cognitive operations needed for task solution, level of calculations use during task solution, form of task setting and solution and especially teaching phase.
- Because of the quick increase of physics and science education efficiency, information about **learning tasks based on hands-on activities** should be inserted into both **pre-service** and **in-service teacher training.**

7. References

[1] Berlyne, D.E. Notes on Intrinsic Motivation and Intrinsic Reward in Relation to Instruction. In: Clarizio, H.F., Craig R.C., Hebrens, W.A.: Contemporary Issues in Educational Psychology. London 1977.

[2] Leutner, D., Fischer, H. E., Kauertz, A., Schabram, N., Fleischer, J. Instruktion-spychologische und fachdidaktische Aspekte der Qualität von Lernaufgaben und Testaufgaben im Physikunterricht. In Thonhauser, J. (Hrsg.). Aufgaben als Katalysator von Lernprozessen. Münster, New York, München, Berlin: Waxmann, 2008, p. 169-181.

[3] Talyzinova, N. F. Utvareni poznavacich cinnosti zaku. Praha: SPN, 1988.

[4] Tolingerova, D. Uvod do teorie a praxe programovane vyuky a vycviku. Odborna vychova, 1970/1971: 21: 77-78.

[5] Trna, J. Motivation and Hands-on Experiments. In HSci2005. Hands-on Science in a Changing Education. Rethymno (Greece): University of Crete, 2005. p. 169-174.

[6] Trna, J., Trnova, E. Cognitive Motivation in Science Teacher Training. In Science and Technology Education for a Diverse Word. Lublin (Poland): M. Curie-Sklodovska university press, 2006. p. 491-498.

[7] Vaculova, I., Trna, J., Janik, T. Ucebni ulohy ve vyuce fyziky na 2. stupni zakladni skoly: vybrané vysledky CPV videostudie fyziky. Pedagogicka orientace, 2008: 18(4): (in press).

Thank you for your attention.

Josef Trna

Masaryk University
Brno, Czech Republic
trna@ped.muni.cz