



## Make learn effectively a " complex knowledge "

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Axe 4: creativity & innovation

## Make learn effectively a “complex knowledge”

### Objective of the study

- ❑ An important number of scientific works has shown difficulties of learning scientific and technological concepts.
- ❑ In French school, pupils used to learn concepts (in term of “*savoir*”) that allow to build knowledge (in term of “*connaissance*”). The “*savoir*” is from scientific and social institutions that we find in textbooks and school curricula. In contrast, the “*connaissance*” is an in-memory structure. Thus, the acquisition of concept allows pupils to access to “*connaissance*” (Ginestié, 2017). However, some particular concepts, such as “*force*” in Newtonian mechanics, due to theirs conceptual, contextual and relational structures, impose to pupils’ cognitive system the elaboration of “*complex knowledge structures*” associated with this concept
- ❑ We make the hypothesis that it’s necessary to help pupils to elaborate each of the knowledge element of this complex set, and to build internal relations between these different knowledge structures (diSessa, 2017; Schneider & Stern, 2010; Bastien, 1997). In order to design the experimental protocol that help to test this hypothesis, an exploratory study presented here, aims to seek teachers’ views about pupils’ difficulties in learning the concept of “*force*”.

### Methodology

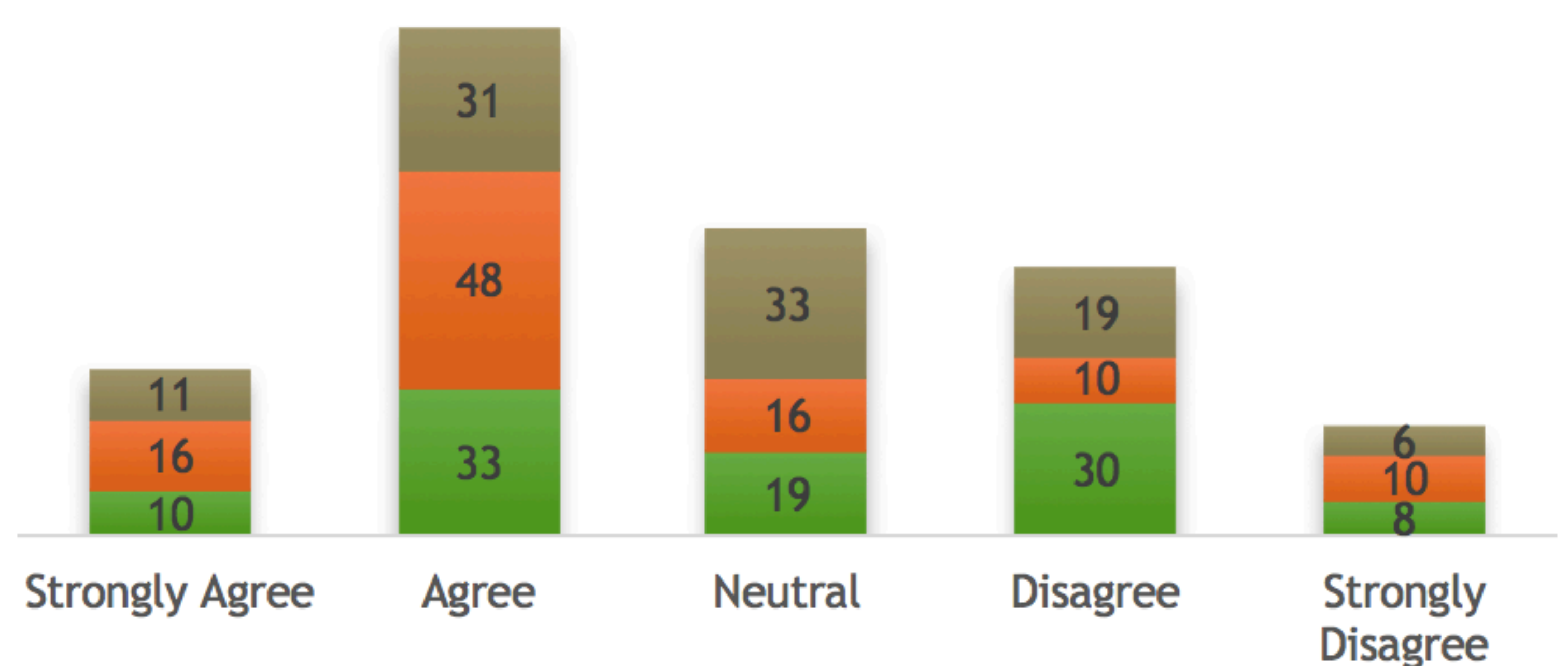
- ❑ A **research questionnaire** is presented to 100 teachers in the Academy of Aix-Marseille to collect theirs views about pupils’ difficulties in learning the concept of “*force*”. Some of the collected data are presented.

	[Force as cause of movement]	Due to acceleration	Due to speed	Acts on the direction of movement
[Force as cause of movement]	↑ 1	0.189	0.105	0.236
Due to acceleration	0.189	↑ 1	0.379	0.125
Due to speed	0.105	0.379	↑ 1	0.337
Acts on the direction of movement	0.236	0.125	0.337	↑ 1

### Results

#### [Force as cause of movement]

■ Due to acceleration ■ Due to speed ■ Acts in the direction of movement



#### Reliability Analysis

- Cronbach’s Alpha coefficient = 0.547 < 0.70 ;
- Std-alpha = 0.5425 ; G6(smc) = 0.5013 ; Average R = 0.2287;
- Ho hypothesis is credible : variables are independent

### Conclusions

- ❖ The data shows that, according to teachers on the pupils’ misconceptions, there are no relations between these motion’s characteristics. Relevantly, the misconception of force as “*cause of movement due to speed*” is the most shared by pupils. This corroborate the strong inking of the core of Newtonian mechanics (Newton’s second Law) in French science teaching (Viennot, 1979) and others (Clement, 1982 ; Twigger & al, 1994 ; McCloskey, 1983).
- ❖ Pupils have difficulties to see differences between acceleration and speed. In fact, the concept of force implements different phenomena in many contexts (Coelho, 2010; Ioannides & Vosniadou, 2002; diSessa & al., 2004). Also, intuitive physics consists substantially of a multitude of fragmented and inarticulate explanatory primitives, activated in specific contexts (diSessa & al., 2004; diSessa, 2017). Thus, learning implies to articulate knowledge elements in memory, with an “*refer to*” link, “*allow to do*” link (Bastien, 1997) in order to elaborate knowledge structures associated to concept (Schneider & Stern, 2010).
- ❖ As follow-up to this study, and based on Instructional Design principles, we try actually to design a strategy allowing to teach effectively the concept of force.

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