The Use of Analogies in Biology and Chemistry at Secondary School Level

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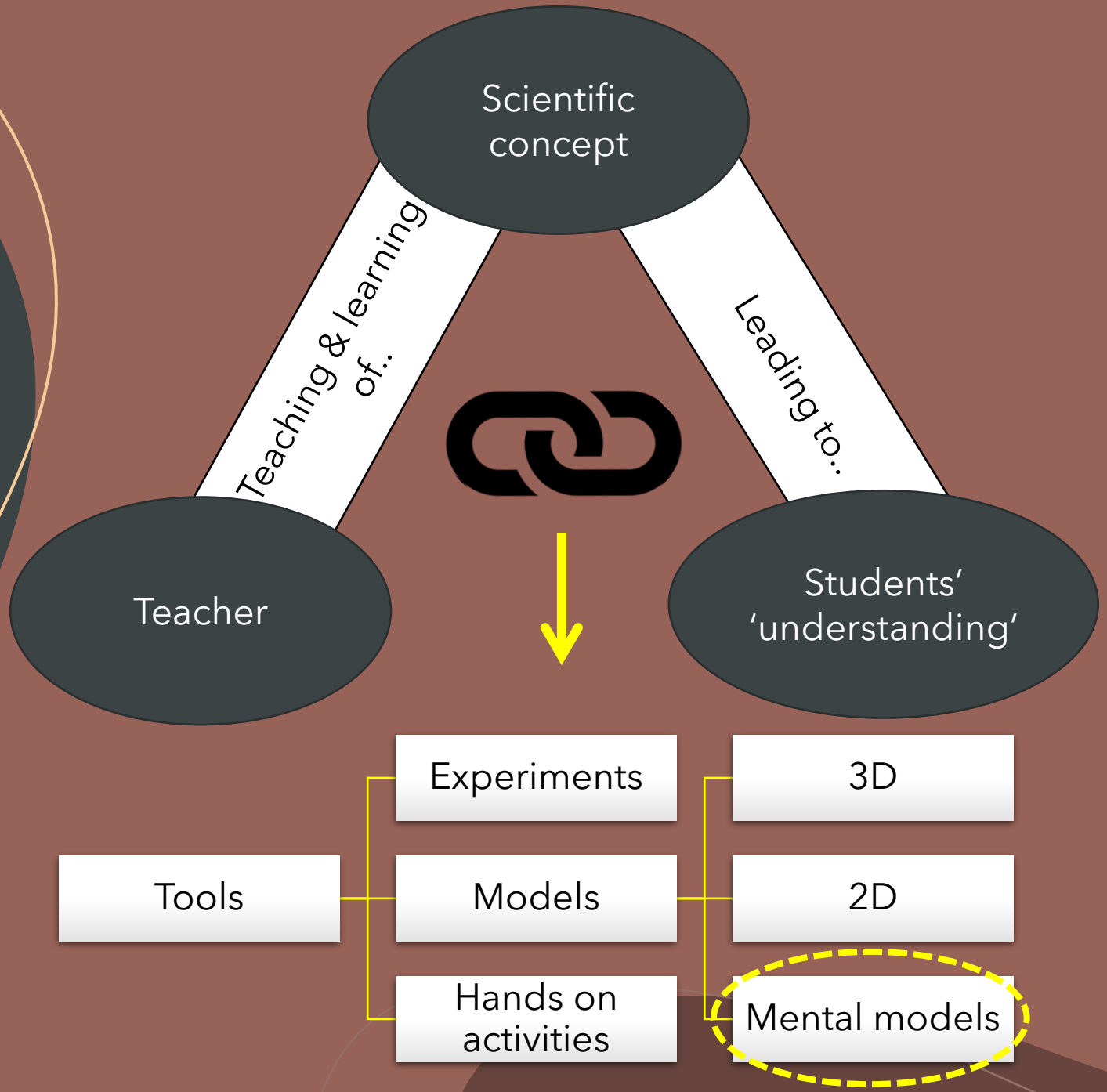
Introduction - Aim



What are analogies?

- **Comparisons** between the analogue (something which is familiar) and the target (which is not familiar).

……How good is the comparison?

- Good analogies
- Bad analogies

Structure Mapping Theory *(Gentner, 1983)*

- **NOT exact replicas** → leads to **advantages** and **disadvantages**

Requires skill to see similarities and differences- **higher order thinking skill**

Can lead to **misconceptions** and **confusion**

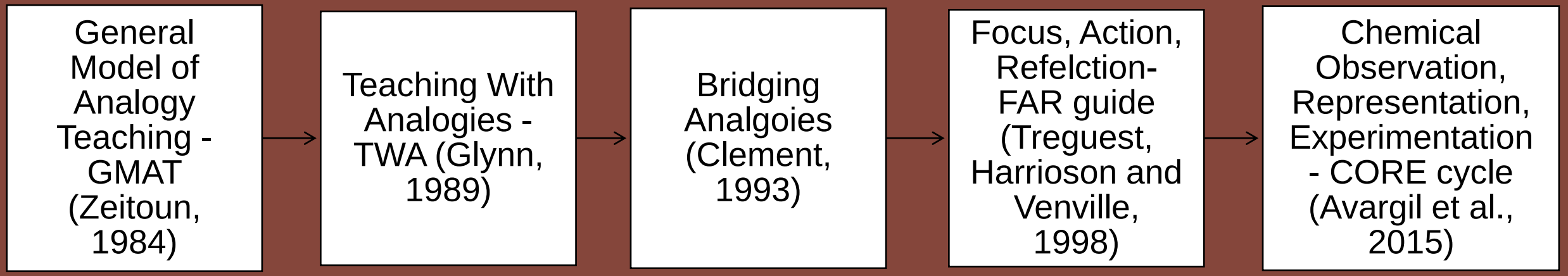
Why analogies as models?

They are a very natural way of learning

(James & Sharman, 2007)

- Are we making use of analogies in our teaching? How?
- Do they require planning?
- Do we question the analogies we use?
- Can we make better use of analogies?
- Can we limit the associated disadvantages?
  - Students constructing analogies
  - Discuss where analogy breaks down

Teaching models



The common factor in the above models is the importance of discussing where the analogy **breaks down** with the students.

The research questions

1. *What do biology and chemistry teachers think about the use, benefits and limitations of analogies?*
2. *What are the teachers' perspectives on using analogies to introduce/explain a topic?*
3. *What are teachers' perspectives on students' analogy construction?*

Methodology

Questionnaire

Section 1 consisting of **5 questions** highlighting the **advantages, disadvantages** and examples of analogies.

Analyzed using **descriptive statistics.**

Section 2 consisting of **15 Likert Scale questions** regarding the usefulness of analogies and an open-ended box for extra comments for 7 of them. Analyzed using:

- **Friedman test** – to compare means scores
- **Kruskal-Wallis** – to compare statements for 3 groups of teachers: Bio; Chem; Bio & Chem

Interviews

10 interviews (5 for biology and 5 for chemistry)

Structured questions for each subject were based on students' worksheet and corresponding marking scheme.

Biology worksheet

- **interpreting** DNA analogies.
- **constructing** analogy for viral replication.

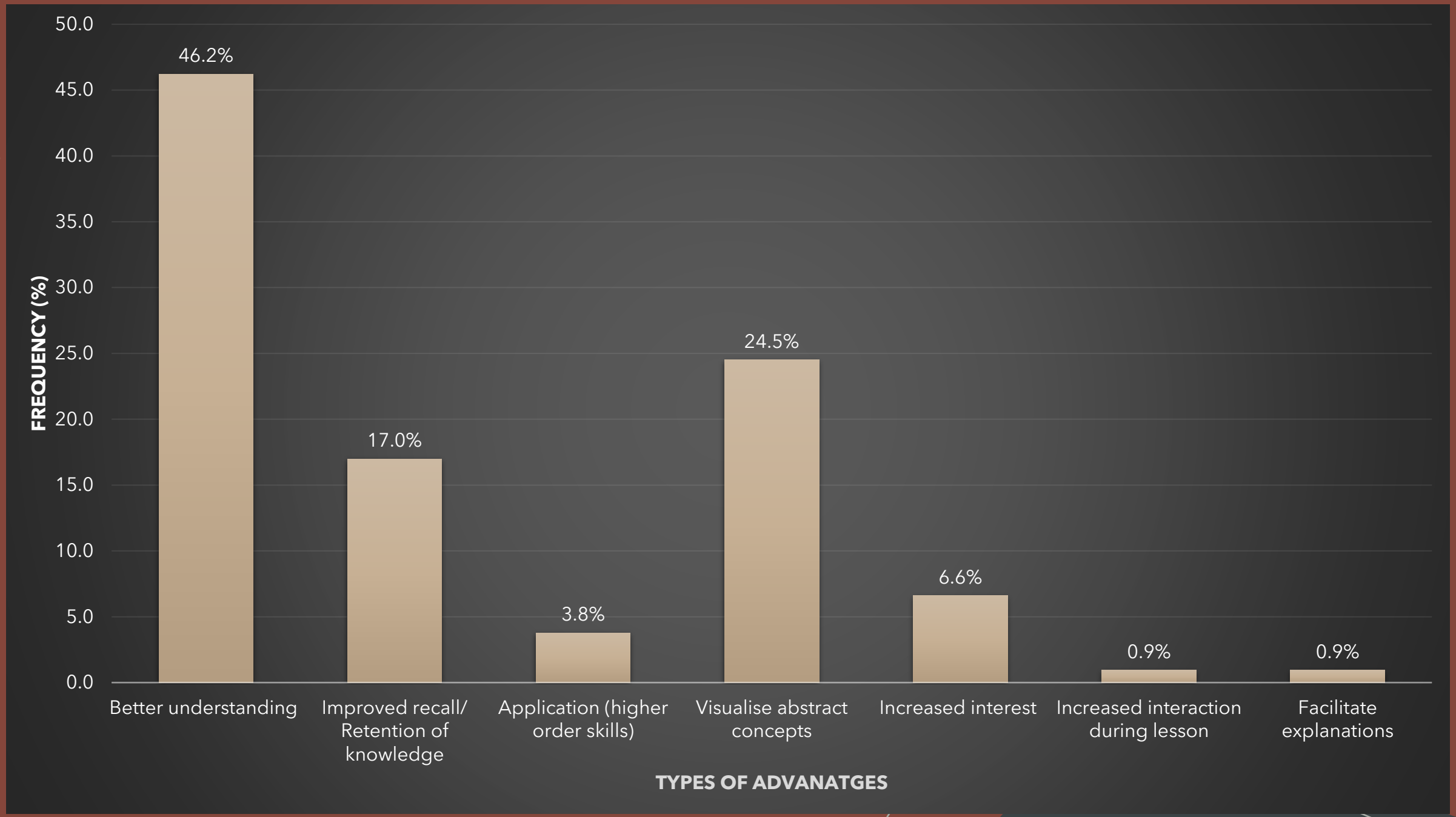
Chemistry worksheet

- **interpreting** polymers analogy.
- **constructing** analogy for ionic bonding.

Questionnaire Results

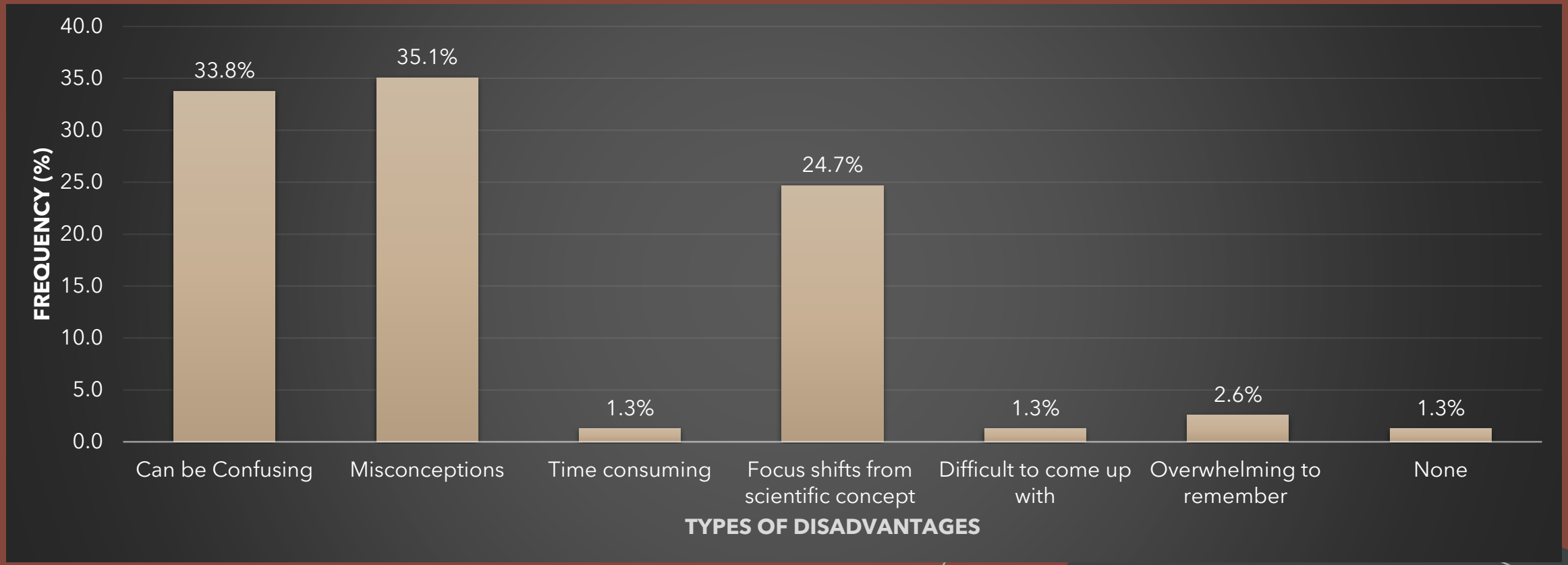
Questionnaire results

- ✓Most teachers (83.6%) correctly defined analogies as ‘comparisons used for understanding’.
- ✓12.3% of the participating teachers confused ‘analogy’ with examples used to explain concepts.


50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
FREQUENCY (%)
46.2%
17.0%
3.8%
24.5%
6.6%
0.9%
0.9%
Better understanding
Improved recall/ Retention of knowledge
Application (higher order skills)
Visualise abstract concepts
Increased interest
Increased interaction during lesson
Facilitate explanations
TYPES OF ADVANATGES

Questionnaire results

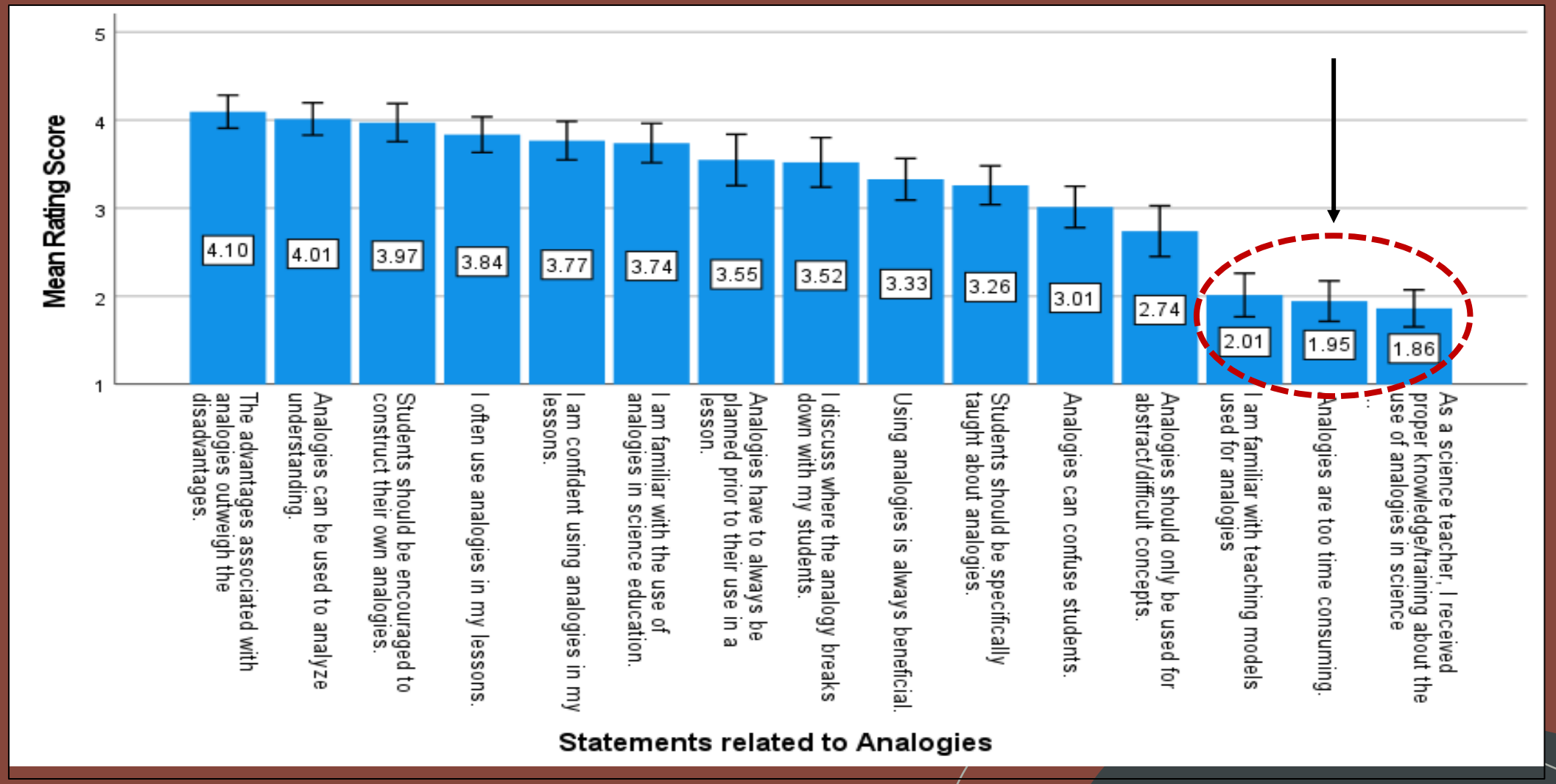
✓Possible generation of **misconceptions** and the potential **misunderstandings** accounted to 68.9% of the disadvantages.



Questionnaire results

- ✓Chemistry related analogies were more complex in nature than biology.
- ✓45.5% of the biology analogies were related to human body systems (moreover, 32.1% → circulation).
- ✓The three most common chemistry topics/concepts cited by teachers were bonding (22.4%), kinetic theory of matter (13.8%) and equilibria (12.1%).

Questionnaire results- Friedman Test



Other salient points

- ✓'Discussing where the analogy breaks down' → mean score close to neutral → should have been higher?
- ✓'Analogies can be used to analyse understanding' → despite high mean rating score (4.01) comments show concerns → they are subjective and not 'universal'
- ✓'Students should be encouraged to construct their own analogies' → interesting 'further comments'…
- ✓'Analogies have to always be planned prior to their use in a lesson' → highest heterogeneity (SD 1.25; MRS 3.55)

Other salient points- Kruskal-Wallis Test

- ✓'Analogies are too time consuming' → Chemistry teachers disagree significantly more than biology teachers ($p = 0.017$)
- ✓'The advantages associated with analogies outweigh the disadvantages' → Biology teachers agree significantly more than chemistry teachers ($p = 0.045$)

Interview Results

The Biology Worksheet

Interpreting the DNA analogies	Constructing analogy for viral replication
Ladder analogy was well received and popular	Challenging for students unless they are specifically trained – and they are not
Computer code analogy – mixed perceptions	Mixed point of views – higher ability or lower ability students fair better?
	Can be a fruitful task

The Chemistry Worksheet

Interpreting the polymer analogy	Constructing an analogy for ionic bonding
Deemed appropriate by most teachers	Challenging for most students → especially for bonding
Visual aids to be used in conjunction with analogy	Some teachers showed concern on topic chosen
Mixed perception re question going beyond syllabus – e.g. heteropolymers	Fruitful task → enhances lateral thinking
Agreed with inclusion of challenging questions	

Common themes between the two subjects

- ✓Overall teachers expressed the need for further knowledge on analogies.
- ✓Felt interested in delving in more depth about this subject.
- ✓Most teachers agreed that to assess an analogy created by a student, it needs to be done more qualitatively → Marking scheme/Rubric?

Final comments

- Teachers are sometimes scared to challenge students → getting confused is part of the process of learning.

Makes us question what we as teachers value the most: knowledge vs skills.

- Which skills? Analogy is a type of learning style, thus should not be imposed. Or should it?
- Need for further teacher training and support.
- More research on using analogies as assessment tools.

Thank you for your attention

Any questions?