Institute of Education

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Can the SOLO Taxonomy support provision for the 'More Able' in Primary maths and science lessons?

(Biggs and Collis, 1982, 1989; Collis and Biggs, 1986)

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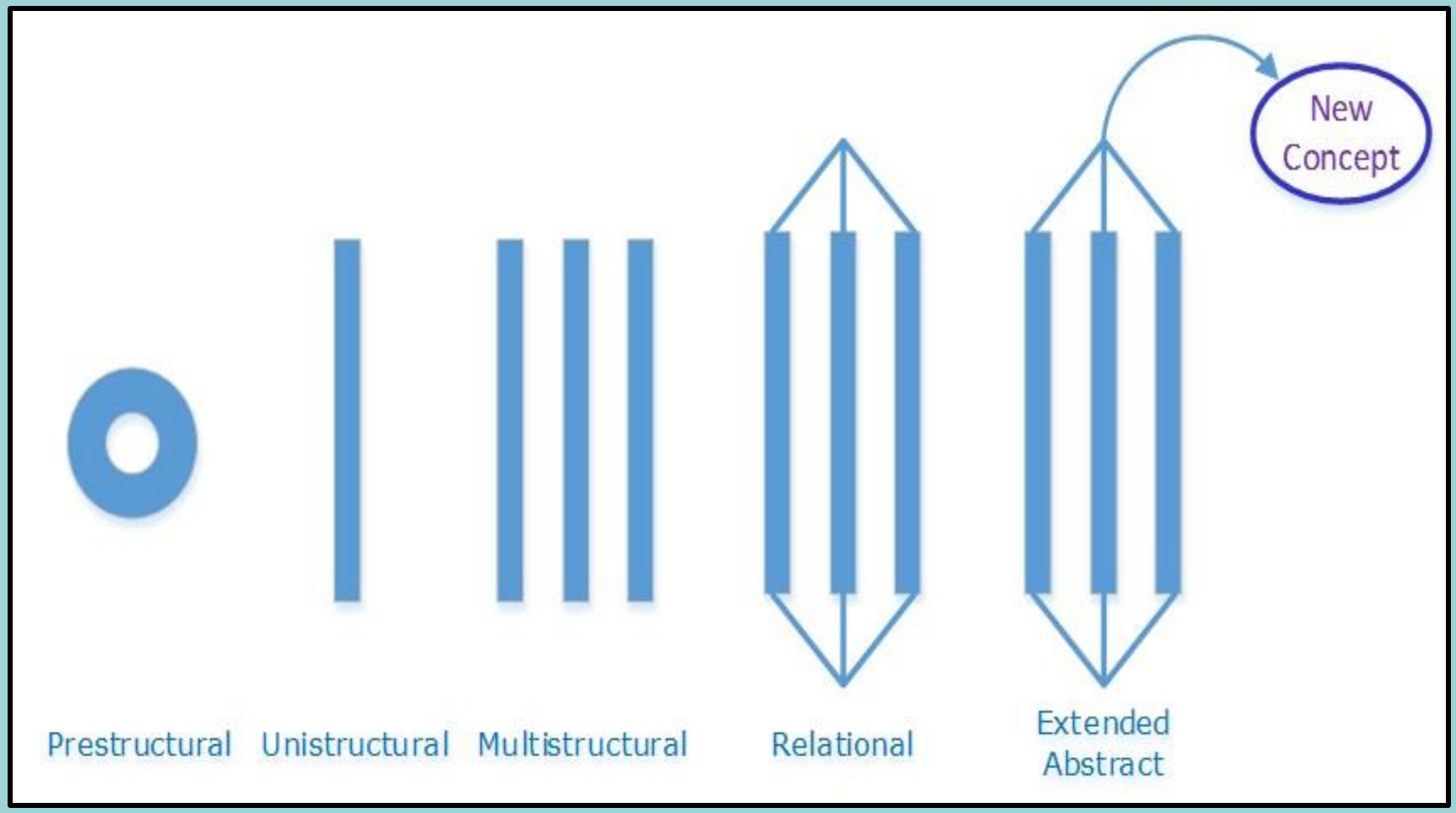
SOLO Taxonomy - Structure of the Observed Learning Outcomes (Biggs and Collis, 1982)



Structure of Observed Learning Outcomes

Research background – considerable research using SOLO in the classroom has predominantly taken place in post primary education; however…

In 2013, Hattie described SOLO Taxonomy as:

'the most powerful model for understanding these levels and integrating them into learning intentions and success criteria' (cited in Hook and Gravett, 2014:3).

SOLO Taxonomy and schools

Beyond Levels Research Project

Hattie, J., and Brown, G.T. L (2004); Hattie, J. (2011, 2013); Hook, P., and Mills, J. (2011); Hook, P., Gravett, C., Howard., M and John, E. (2014); Hook, P., and Tolhoek, W. (2017); Martin, S. (2015)

SOLO: Structured Observation of Learning Outcomes – Why is it useful?

- Scaffolds learning
- Personalises learning – enables children to be engaged in their own learning and assessment, teacher to meet the diverse learning needs of pupils
- Encourages higher order thinking skills in pupils
- Can be used as a tool for monitoring progress in mathematical and scientific thinking and application
- Gives children own agency
- Connect areas and big ideas of maths and science
- Promotes a Growth Mindset (Dweck, 2006) as it sees mistakes as part of the learning journey
- Common understanding and language of learning that helps both pupils and teachers understand and assess the learning process = Learning-focused relationships
- Provides challenging learning intentions for all pupils
- Encourages intrinsic motivation

Rationale for using SOLO with the 'More Able'

'SOLO can be used by students as a model to self-assess their functioning and declarative knowledge outcomes for different tasks. With SOLO, the focus is on the complexity of the structure of the student response, rather than on a categorisation of the student themselves.'

Hook, P. (2011) Using SOLO in the maths classroom. Essential Resources. (www.pamhook.com)

Rationale – the 'More Able' and schools

- Ofsted Inspection Framework (2015) focuses on Pupils deemed 'most able' (NACE, 2016)
- DfE (2015)– there is no national definition of 'most able' and Ofsted does not define this either
- There is no requirement to have a specific More Able Registry or a 'More Able Policy' although NACE (2016) considers it to be good practice.
- With the removal of levels; a school's internal tracking will be used to identify the 'most able'
- Current emphasis in the Primary Mathematics and Science Curriculum to develop the breadth of children's mathematical and scientific thinking skills
- Classrooms are still dominated by surface level or knowing lots – much of classroom life is knowledge telling; and tell and practice; teachers need to understand levels and complexity of knowing (Hattie, 2011 cited in Hook, 2013)
- Headteacher reflections (from the schools who took part in this project) reflect Hattie's argument and Shulman PCK (1986).

In a mathematical context, pupil responses at each SOLO level categorised as…

SOLO unistructural and multistructural

I can recognise a fraction

I can find equivalent fractions
I can simply fractions
I can convert between fractions and mixed numbers
I can multiply integers (no connections)

SOLO relational

I can multiply fractions together and know how to deal with mixed number answers

SOLO extended abstract

I can recognise when I need to use multiplying fractions in word problems and new situations; I can make generalisations about multiplying fractions; I can apply the solution to novel situations; I can make qualifications

(Gareth Williams, 2013)

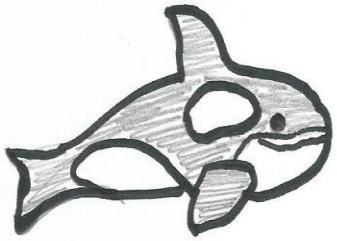
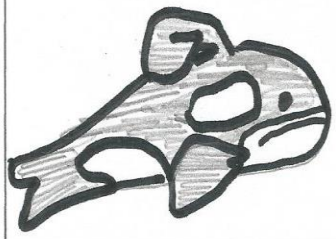
In scientific context, pupil responses at each SOLO level can be categorised as…

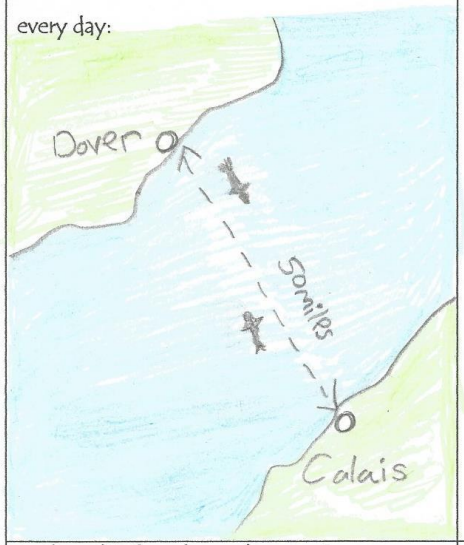
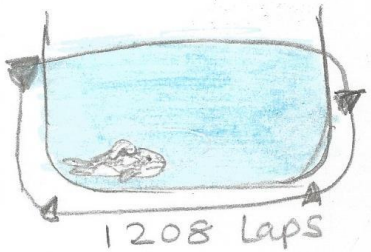
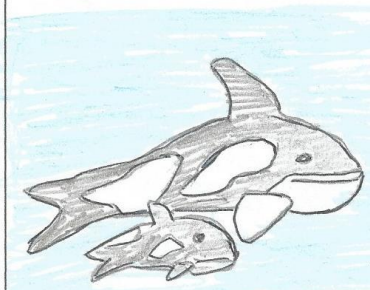
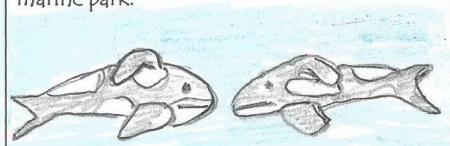
SOLO unistructural and multistructural (quantitative)
Can you identify the various forms of energy?
(surface understanding)

SOLO relational (qualitative)

(deep understanding)

SOLO extended abstract (qualitative)
The pupil re- thinks their new understanding at the relational level, looks at it in a new way, and uses it as a basis for a prediction, generalisation, reflection; for example, I think we should care more about habitats, because changes affect the survival and reproduction of the organisms that live there.
(conceptual understanding)

It is rare for an orca in the wild to have a collapsed dorsal fin, if this is the case, the reason is because the fin has been injured or damaged. In the wild, orca dorsal fins look like this: 	In captivity, orcas spend most of their time on the surface of the water – because of gravity, a lack of support from the water, and being fed an unnatural diet, orca dorsal fins look like this: 
Orcas live longer in the wild! In the wild, average life span for male orcas is 30 (max 50-60 years) ; female 46 (max 80-90 years).	In captivity, the average life span for male orcas is 17 and 27 for females.

In the wild, orcas can swim up to 100 miles every day: 	In captivity, orcas are trapped in a tank, they would need to swim 1,208 laps around the tank every day to equal what they would swim in the wild. 
In the wild, there has only every been one reliable report of an orca harming a human. 	In captivity, orcas have attacked and killed 3 humans since 1991 and injured many others because of the stress of being derpived a natural life. 
In the wild, orcas are highly social animals, living in pods from 2 – 15, calves are raised by the pod . In some pods, calves stay with their mothers for life. 	In captivity, orcas are forced to live with orcas from other pods, are moved between facilties for breeding and to perform. Tilikum, was snatched from his mother when he was just 2 years old – taken form his family, he was kept ina holding tank for almost a year before being transferred to a marine park. 

Methodology

- The research ran for 6 weeks across the second half of the summer term (2017) and was exploratory in nature, it was teacher led (action research)
- 2 schools – 8 teachers in total from KS2 (2x Y3, 2x Y4, 2x Y5, 2 x Y6)
- Qualitative data was collected (children's work, teacher's planning, researcher's notes and interviews with teachers) from 12 maths lessons (12 hours) and 6 science lessons (12 hours)
- Teachers given CPD re SOLO prior to starting the project by researchers
- Weekly meetings were held between the researcher and classroom teachers to support their understanding of SOLO Taxonomy
- Teachers used the resources provided by HOOKed resources (www.pamhook.com) to plan the lesson – all children took part in the lessons but only data from the more able was collected by the researcher.
- The data from two boys and two girls who had been identified as more able by the classroom teacher (using school data and analysis) was collected for each class.
- Ethics – consent was given by Headteachers, teachers, children's gatekeepers (parents, carers) and the children themselves.
- Full ethical approval for REC 968 Can the SOLO Taxonomy support provision for the 'More Able' was granted by UCL/IOE. Data protection registration number: Z6364106/2017/06/110

How was SOLO used in this project?

- Planning – to structure lesson aims/objectives
- Success criteria – to structure steps to success for learning outcomes
- To differentiate one or the same task for the whole group/class – this being particularly important given the changes to the Primary National Curriculum and the teaching and learning policy of the schools that took part
- Used SOLO-coded questions as strategies to prompt pupils to deepen their mathematical and scientific understanding (moving from level to the next and reflecting on their next steps)
- As a scaffold to enable children to connect their ideas and think mathematically/scientifically
- SOLO Verbs – used to enable the children to articulate their explanantions
- As a framework for answering exam style questions (Year 6) – maths only
- Pupils used SOLO in the classroom to look explicitly at their own progress/learning

Outcomes – Maths and Science

1. Encouraged intrinsic motivation

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Outcomes – teachers

- Powerful in terms of assessment especially pupil self-assessment
- Different way to look at progression rather than achievement – teacher expectations not only for the more able but all children in the class.
- Cross curricular connections became evident
- Questioning is key; CPD needed
- CPD - Knowing and identifying what abstract thinking is and what it looks like, plus understanding that this is informed by multistructural understanding
- CPD - Subject knowledge, especially for non maths and science specialist teachers
- All tasks are not applicable to the higher levels of SOLO
- Encourages children to push themselves and have higher expectations of themselves
- Hierarchy of SOLO helped teachers to plan
- Scaffold – to enable children to make links in and between their learning
- Language - SOLO verbs and scaffolding
- Enabled the 'more able' to build perseverance
- Some teachers found differentiating between multistructural level and relational level problematic
- Extended abstract – what does this look like for some tasks?

Limitations of the research

- 6 weeks exploratory study – a glimpse
- Time constraints for teachers
- More structured approach needed to better support teachers
- Whole school approach possibly needed
- Small – scale research
- More CPD needed prior to the research

Implications for future research

- Longitudinal studies
- Extended abstract – teacher pedagogy (Shulman, 1982) for maths and science in relation to the Primary National Curriculum starting at KS2
- Larger scale project needed, incorporating schools from various demographics
- Teaching resources and tasks development needed

References

- Biggs, J. B., and Collis, K. F. (1982) *A system for evaluating learning outcomes: The SOLO taxonomy*. New York: Academic Press.
- Biggs, J., and Collis, F. (1989) Toward a model of school-based curriculum development and assessment using the SOLO taxonomy, *Australian Journal of Education* 33: 151-163.
- Collis, K. F., and Biggs, J. B. (1986) Using the SOLO Taxonomy, *Research Information for Teachers*, (2); 4.
- Hattie, J., and Brown, G.T.L. (2004) *Cognitive Processes in Assessment Items: SOLO Taxonomy (Tech. Rep. No. 43).* Auckland: University of Auckland, Project asTTie.
- Hook, P., and Gravett, C. (2013) *SOLO Taxonomy in Mathematics*. Essential Resources.
- Lilly, J., Peacock, A., Shoveller, S., and Struthers, D. (2014) *Beyond levels: alternative assessment approaches developed by teaching schools*. Research report.
- Martin, S. (2011) *Using SOLO as a Framework for Teaching; a case study in maximising achievement in science.* Essential Resources.
- Ofsted (2015) *School Inspection Handbook.* Ofsted: London.