

## NE2 RIWG Cognitive Science Case Study

**Question:** How can we utilise research to inform practice? (April 2023)

*“Understanding is necessary to evaluate new information; the more a person can contextualise what they’re being told, and evaluate it from many angles, the less likely they are misled by manipulative language, ill-informed data, poorly sourced evidence or pure advertising.” (Ephrat Livni 2017)*

This statement in itself may provide concern with some participants, there is a need to understand that ‘bias’ is evident in all things, knowing this can provide a more transparent approach to research.

The important thing from the project was that individuals created their own ‘bias’ as the project developed. Each participant felt a need to relate to information being presented, be open enough to discuss any that contradicted their beliefs regarding their current practice/curriculum.

*‘Having the opportunity to discuss thoughts, reasoning and ideas with other maths leads surrounding manipulatives was highly valuable experience.’*

The focus of the project was to determine ‘why’ schools use manipulatives and as a consequence explore how they are being used in the classroom, more importantly how are the use of manipulatives influenced by external factors (groups, companies, research, etc.) and how that agenda can play a major role in choices made in the classroom.

### Introduction

In the current curriculum, using manipulatives are perceived as ‘good practice’, external organisations quote the work of Bruner, Vygotsky and successes from curriculums around the world. Schools are led by mathematical organisations who quote that a **Concrete, Pictorial** and **Abstract** is by application part of a quality devised curriculum. The research supports this notion, *Ofsted* place this in their framework (not specifically but the understanding is there) and schools are reviewed, inspected and reported with this strategy in mind.

With this in mind, the project was designed to explore the decisions schools may need to make to ensure that their curriculum is their own and that any ‘tools’ used within it were right for the pupils. This gave rise to the question: **‘What exactly are manipulatives and how do we understand the purpose behind ‘why’ they are used?’**

As lead of the project there was a realisation that both viewpoints would be necessary to provide participants with a transparent experience, while deliberately explaining the ‘bias’ aspect of the project.

*‘Honesty, experience and openness of the lead made the sessions an incredible success.’*

During the preparation of the sessions, information was gathered, read, stored and broken down into smaller parts. The theory was that the sessions were time restricted, discussion needed to be focused while making available the complete article, document etc, for participants to read during the intervening times. It was made clear that further discussion would occur in each subsequent session, this provided each participant with an opportunity to read the information in full, gain a greater insight of the context in which it was

written, provide a deeper understanding of size and origin of the information and an independence regarding bias they may feel existed in the work.

*, ‘Opportunities for professional discussion around manipulatives, time to reflect on and discuss the use of manipulatives. Time to look at research extracts and having something physical to take away from the sessions that has been worked on collaboratively by experienced colleagues was such a positive experience.’*

### Strategy (Accessing Research)

For each piece of research a variety of questions was central to each session. Participants were provided with questions that were intended to engage and stimulate discussion throughout. The overarching model was based on the Scaffolding Framework (EEF – Self Scaffolding, Prompting, Clueing, Modelling and Correcting question types)) model to provide a structure during interaction.

The structure regarding identification of research to incorporating in each session is listed below.

<b>Process</b>	<b>Session Structure</b>
<ul style="list-style-type: none"> <li>• <b>Search</b> for articles, documents, blogs etc. that provided information regarding manipulatives. <i>Each search began as a broad trawl throughout the internet, a thread was decided upon and bias quickly became part of the process (information that suited/contradicted the Project question and complimented the conclusion)</i></li> </ul>	<p><b>Instigate</b> Present the idea or open up a new line of enquiry.</p>
<ul style="list-style-type: none"> <li>• <b>Identify</b> bias (positive or negative view – important not to over complicate with the nuances of research). <i>Introduce an ‘Exploratory Question’ This form of question looks to understand something without influencing the results. The objective of exploratory questions is to learn more about a topic without attributing bias or preconceived notions to it. (Research Question Example: Asking how manipulatives are used in your school?)</i></li> </ul>	<p><b>Build</b> Develop, add to or elaborate on an idea.</p>
<ul style="list-style-type: none"> <li>• <b>Summarise</b> key points and highlight. The intention is to draw attention to phrases etc. to focus discussion. <i>Focus was around Predictive Questions - Predictive research questions are defined as survey questions that automatically predict the best possible response options based on text of the question. Moreover, these questions seek to understand the intent or future outcome surrounding a topic. (Research Question Example: Asking why you use that manipulative in school for that area of mathematics?)</i></li> </ul>	<p><b>Challenge</b> Disagree or present an alternative argument.</p>
<ul style="list-style-type: none"> <li>• <b>Debate</b> – set up a series of questions to stimulate discussion with participants. <i>Predictive Questions were often used in this aspect of the project. Predictive research questions are defined as survey questions that automatically predict the best possible response options based on text of the question. Moreover, these questions seek to understand the intent or future outcome surrounding a topic. (Research Question Example: Asking why have dienes/Place Value counters been promoted to be used in Addition and Subtraction in the Mathematics curriculum?)</i></li> </ul>	<p><b>Clarify</b> Asking questions to make things clearer and check understanding.</p>

- **Deepen** – participants read complete article (and others they may have located) and identify, summarise to provide debate in subsequent session(s). This is to ensure ownership, personal bias. *Focus on Quantitative Research Questions. Quantitative questions prove or disprove a researcher’s hypothesis through descriptions, comparisons, and relationships. These questions are beneficial when choosing a research topic or when posing follow-up questions that garner more information. This was often linked to Descriptive Questions. It is the most basic type of quantitative research question and it seeks to explain when, where, why, or how something occurred. Moreover, they use data and statistics to describe an event or phenomenon. (Research Question Example: How did the research influence your decision making process? How has external influences affected the choices you make in the implementation of manipulatives in your school?)*
  
- **Review** the article and discuss validity regarding personal opinion, viewpoint etc. (bias). *Comparative Questions are an option to engage participants in further discussion/debate. Sometimes it’s beneficial to compare one occurrence with another. Therefore, comparative questions are helpful when studying groups with dependent variables. (Example: Do Bar models and Part-whole models reflect the same mathematical understanding? Are they transferable (longevity) throughout the curriculum?)*
  
- **Apply** the finding into their own practice, building a framework for a manipulative approach in the curriculum. *Relationship-Based Questions This type of research question answers influence of one variable on another. Therefore, experimental studies use this type of research questions are majorly. (Example: How does a Numicon approach differ from a Base Ten approach? How does dienes differ from Place Value counters?)*

**Probe**  
Dig deeper, ask for evidence or justification of ideas.

**Summarise**  
Identify and recap the main themes/ideas.

**Model**  
Articulate the thought processes underpinning the task, discussion or debate.

**Mark**  
Highlight an important idea or type of contribution.

Each of the question types are interchangeable and can be used in isolation or as a combinational approach throughout any project.

### Further Questions incorporated to Deepen and Reflect on Understanding

Questions are wide ranging and generic; this is to provide participants with the opportunity to use them within their setting across numerous research based activities.

1. Why does this study matter?
2. Why did you want to do this study?
3. How does this study relate to your other work?
  1. What information do I need?
  2. Where do I find information?
  3. Which information can I trust?
4. What will be your role following this study?
5. What surprised you the most from the research?

6. Did you change any of your or your school's thinking as a result of anything you learned from this study?
7. How can I use new information in my current practice, school curriculum, pupils lessons?
8. How do I use this information ethically?

Specific approaches were also incorporated into the sessions, "*How to Read a Research Paper: The R3I Method*" by Carrie Conaway, strategy was applied to deepen participants access to research.

To quickly find the information you want and need in a research paper, we recommend the R3I Method—reading for relevance, inference, impact, and importance.

**Relevance.** Is the paper relevant to the problem you are trying to solve? Is this intervention aimed at an outcome you want to change? If so, is the intervention something you might actually try? How and why did the intervention work, and are those same conditions in place in your context?

**Inference.** Does the study's methodology support the inference it is trying to make? Often research aims to infer that an intervention caused an outcome. To measure causation, not just correlation, the study must account for the fact that people who participate in an intervention are likely to be different than those who do not, especially when they choose whether to participate. Randomly assigning some people to participate and others to serve as a comparison group is the best way to manage this problem, so as a non-research expert, look for words like experiment, quasi-experiment, randomized controlled trial, or random assignment to be sure the researcher addressed this issue.

**Impact.** Is the impact positive or negative, and how big is it? In particular, is the impact big enough to matter educationally, and is it worth the resources it would require to implement?

**Importance.** Are the findings statistically and practically important?

The following chart summarises where you're likely to find R3I in an academic paper.

Paper Section	Should you read it?	What will you find?
Abstract	Yes!	Most or all of R3I
Introduction	Maybe	Most or all of R3I
Background	Maybe	Relevance
Intervention or context	Yes!	Relevance
Data or sample	Maybe	Relevance
Methods	Probably not	Relevance

Paper Section	Should you read it?	What will you find?
Results	Maybe	Impact, Importance
Discussion	Yes!	Most or all of R3I

Further options were used within the session, work by Jamie Birt (Updated October 1, 2022)

When you need certain facts, information or input, how you phrase your request often impacts the quality and type of response you receive. In the workplace, different situations may require you to utilize various techniques for asking questions in order to preserve relationships and communication. Learning about unique question types can help you determine which ones are appropriate for a specific workplace situation.

### Why is asking the right type of questions important?

Asking the right types of questions at work is important because doing so can help you gather the information most relevant and useful to you. Your goals for communicating with colleagues, managers or trainees should help determine what types of questions to pose.

You may simply need a single, brief answer without discussion. Other times, you may want to talk through a scenario, evaluate how well a group is learning new material or solicit feedback. The types of questions you ask directly impact the type of answer you receive.

Here are fifteen types of questions with examples that were used in the sessions:

#### 1. Closed questions

Closed questions have two possible answers depending on how you phrase it: “yes” or “no” or “true” or “false.” You can use closed questions to get direct information or to gauge someone’s knowledge on a topic.

For example:

- Do you use research in school to inform practice?
- Does research influence your thinking? (*This was used to engage if a further conversation*)
- Are you influenced by external opinions regarding your school curriculum? (*This was used to engage if a further conversation*)

#### 2. Open questions

Open questions are the opposite of closed questions in that they facilitate lengthier, more thoughtful answers and discussions among groups. These questions don’t invite “yes” or “no” responses and instead encourage the listener to respond with detail.

Here are examples of open questions:

- What is the best way to learn about manipulatives?
- Why did you use dienes for that activity?

- What was your first experience of manipulatives in class?

### 3. Funnel questions

Unlike other types, funnel questions are always a series of questions. Their sequence mimics a funnel structure in that they start broadly with open questions, then segue to closed questions. The sequence can also take the opposite form, such as starting narrowly with straightforward closed questions and broadening into subjective open questions.

Consider this sequence of example funnel questions:

- Did you find the research valuable in the presentation?
- What did you like most about it?
- What sorts of things would you have liked to add to the presentation?

### 4. Leading questions

Leading questions encourage the listener to provide a specific response. Often, speakers phrase these questions to encourage the listener to agree with them. It's a good idea to use these questions sparsely, as others may view them as manipulative if you use them frequently or in the wrong context.

Some examples of leading questions are:

- Don't you think Numicon would be the most appropriate tool for this aspect of mathematics?
- Wouldn't you like it if you could guarantee that Place Value Counters were the most effective tool in mathematics?

### 5. Recall and process questions

While these are two different types of questions, they both relate to gauging the listener's knowledge. A recall question asks the listener to recall a specific fact, such as:

- "What is the school's vision for manipulatives?"
- A process question allows the speaker to evaluate the listener's knowledge in more detail.
- "Why is your school's vision statement for manipulatives effective?" is a process question.

### 6. Rhetorical questions

Rhetorical questions illustrate a point or focus attention on an idea or principle. Because speakers use rhetorical questions to persuade others, these questions typically don't require a response. You're less likely to use rhetorical questions in everyday conversations with colleagues, but you may use them in formal presentations, speeches or sales pitches.

Some examples of rhetorical questions are:

- Wouldn't it be great if you had one manipulative that could be used for all areas of mathematics?
- Who cares if we don't use dienes for addition?
- Who will maintain the school's implementation of manipulatives?

### 7. Divergent questions

Divergent questions have no right or wrong answers but rather encourage open discussion. While they are similar to open questions, divergent questions differ in that they invite the listener to share an opinion, especially one that relates to future possibilities.

Consider the following divergent questions:

- How might you improve your current use of manipulatives in school?
- What do you think would happen if manipulatives were removed from class?
- Why don't research groups agree on using manipulatives in school?

## 8. Probing questions

Probing questions are follow-up responses to the listener's answer to a previous question. Probing questions help speakers understand a listener's perspective, decipher their meaning and encourage more in-depth reasoning. Probing questions include:

**Clarifying questions:** Clarifying questions help teachers or leaders ensure group members understand the current material. They also help teachers understand what a student is trying to convey through a statement or question, such as asking, "What do you mean by the CPA?"

**Critical awareness questions:** Critical awareness questions require listeners to understand and apply information analytically to reach a conclusion. For example, a teacher can ask, "What evidence do you have to support your answer?"

**Refocusing questions:** Refocusing questions to help members return to the point of the discussion if answers are becoming unrelated or incorrect. For instance, you could ask, "If that answer is true (*with regards to how Mathematics Manipulatives Industry influence our decisions*), how could it affect the future?"

**Prompting questions:** Prompting refers to helping learners reach the right answer with additional clues or context. For instance, if a participant cannot answer your question about how Numicon can be used to solve addition fractions calculations, you might interject by asking how is Numicon used to understand number relations and then move to adding two numbers together and progress to concept of adding fractions and what similarities/differences there are.

**Redirection questions:** Teachers can involve more participants and help others think critically about information by allowing other group members to add to, object to or clarify another participant's answer. For instance, if Participant A only remembers two of the five core values of using dienes in Addition, you could redirect the discussion by saying something like, "can anyone, can you add to Participant A's answer?"

## 9. Evaluation questions

Teachers or supervisors use evaluation questions to help students or participants to use their knowledge to make value judgments or anticipate future events or outcomes when leaders do not provide this information. These questions require information organization and analysis.

For example, you could ask questions such as:

- Using what you know about manipulatives, which one would you use to teach addition and subtraction and why?
- After reviewing your curriculum policy, which manipulatives would you focus on in your school to ensure consistency, clarity and longevity?

## 10. Inference questions

Inference questions require learners to use inductive or deductive reasoning to eliminate responses or critically assess a statement. Inductive reasoning is the process by which you arrive at a generalisation using specific, known facts. For instance, you may deduce that, because all schools who are involved in Mastering



Number use Rekenek, progress and achievement will be the same. You use what you know to make a broader statement that could be true based on the facts.

Deductive reasoning occurs when you make predictions based on generalisations that you assume to be true. For instance, if all successful schools use Place Value Counters for Addition and subtraction, and those schools get good results nationally, deductive reasoning tells you that all other manipulatives are unnecessary in your Curriculum.

### **Examples of inference questions:**

Numicon is the most commonly used Manipulative in Early Years and has the most success with understanding number bonds and relationships between numbers, so why would we use any other manipulative?

- If you only use Cuisenaire Rods for multiplication and Division, what do you imagine the outcome will be in your curriculum?

### **11. Comparison questions**

Comparison questions are higher-order questions that ask listeners to compare two things, such as objects, people, ideas, stories or theories. They require a thorough understanding of the learning material and the ability to identify and describe similarities and differences. Similar to other questions, you're likely to use comparison questions in an education or training situation.

You could ask comparison questions like:

- What are the major similarities between using Dienes Blokes and Place Value Counters?
- Can you compare and contrast the similarities and differences between a Bar Model and a Part-Whole Model when teaching Addition and subtraction of Decimals?

### **12. Application questions**

Application questions ask students or participants to apply an idea or principle in a new context to demonstrate higher-level learning.

For example, you might ask questions like:

- How did the person in the video use manipulatives to clarify understanding regarding fractions?
- What factors might lead your school to introduce STOP, transition/transfer points into your practice/curriculum?

### **13. Problem-solving questions**

Problem-solving questions present students with a scenario or problem and require them to develop a solution. For example, you could pose the following questions to staff/pupils after discussing school's policies and procedures with regards to manipulatives:

- How would you utilise manipulatives in lessons?
- What would you do if a manipulative was removed from the curriculum policy?
- How would you ensure pupils understood how to use manipulatives, including the autonomy to choose for themselves?



## 14. Affective questions

Affective questions seek to learn how others feel about the information they're learning. These responses can help the speaker affirm the listener's feelings or clarify information.

For instance, you may ask participants questions like:

- How do you feel about the use of STOP points?
- What are your initial reactions to creating transition/transfer opportunities in the curriculum?
- Is it important to you that we offer guidance for schools with regards to manipulatives?

## 15. Structuring questions

Structuring questions ensure group members understand the information you are presenting to them. They allow learners an opportunity to clarify material or ask follow-up questions.

For instance, after a presentation, you may ask the following questions:

- Does anyone have any questions?
- Was that section clear to everyone?
- Did that quote make sense to you?

## Recommendation

It was important that throughout the project, research was accessible, applicable and open to scrutiny. As the lead openness to change was vital, whether this was directional (Session three was purely around testing a piece of research), antagonistic (challenging perceptions on manipulatives), contradictory (beginning with one view and ending on another one) or as the connection between theory and practice. There was a determination not to simply create a 'done to' model with the group, otherwise the external influence would continue and true reflection/ownership would not occur in each participant.

## Conclusion

The project provided participants with an insight into how research was accessible and often complimentary to their provision in school. Throughout, it was important that reflection was a priority, the project was designed to constructively challenge participants' existing beliefs regarding their decisions on manipulative provision in school. Questioning was aimed at providing opportunities to evaluate the impact of a manipulative centred curriculum both on their colleagues and pupils in school. External perspectives often play a major role in the decision schools make and it was vital that these influences were explored, their own orthodoxies needed challenging to raise self-awareness in their own understanding of 'why' manipulatives are used in mathematics. During the sessions it became clear that change was occurring, change that would be sustained in their own school community. A window was opened for the participants, ownership explored and evidence-informed research became available to support school based changes that were going to occur.

## References

Ephrat Livni 2017 <https://qz.com/1123896/its-better-to-understand-something-than-to-know-it>

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<http://www.research4schools.org/blog-post/how-to-read-a-research-paper-the-r3i-method/>

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