

# Problems Unsolved

Incomplete Military and USG Research Initiatives on  
Education, Heuristic Discovery, and NextGen AI

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# What the Government Wants Resolved

There have been two segments addressing what DARPA and the Government want and have not gotten. This document will quickly summarise the overlap of what problems the Government has and is waiting to see solutions for in the market. Please note that IN-Q-TEL, Benchmark, and Accel do not hold any companies that adequately address these problems as per DoD literature.

## Set-Theoretic Granularity in Education Modules and Information

Granularity in Education Modules is an answer to the problem presented by a bachelor's degree in Computer Science. Having the BS does not indicate exactly what information was learned and what overlap there might be with a BS in Mathematics. So, if one had to take a BS in Mathematics and already had a BS in Computer Science, caution could lead to redundancy and trust could lead to knowledge gaps.

When assembling teams for complex projects, the more granular the knowledge analysis, the better. The problem then becomes the organisation of the granules, which may be solved with set theory and crowdsourcing.

Set theoretic granularity enables a TLA (Total Learning Architecture) to solve other problems in education, such as Knowledge Gap Discovery, Standardized Psychometrics, and Optimisation in Concept Learning. It also allows modules to be interoperable between courses and curricula. For example, understanding of dot products of matrices is the same in general

math as it is in physics or computer science, a single lesson on this subject could be used across a multitude of classes.

This granularity isn't just important to education modules, it's also important to information in general. Granular information may be unioned with other data to prevent overlap, ensure legitimate identification, facilitate knowledge verification, and lead to strong, yet flexible, schemata for metadata of objects of interest.

## Reliable/Trusted Psychometrics for Module/Field Competence

More specific to Education, once education modules have granularity and interoperability, a TLA may now go about solving the problem of developing Reliable and Trusted Psychometrics for competence in these granules. Within TRADOC, ADL and other military agencies, there seems to be confusion with (1) what these modules should be built of and (2) the nature of knowledge and competence itself. These problems are perceived to concern Epistemology and Ontology as much as they do data infrastructure.

This has led the military to have a variety of different standards and different ways to interpret those standards. The current state of this system is so byzantine in nature that it was not possible to address these standards within this report.

Second to developing Module Competence, is developing narrative within these modules to develop real expertise, as spontaneous expertise has not been found to result from memorisation of sterile modules. It requires concept learning.

## Education Entropy - Maintenance of Competence

Once a TLA has granularity and valid psychometrics for competence, it may now begin solving the problem of addressing

the decay of competence from disuse, ensuring that competence is maintained rather than just tested once. To return to the problem of the BS in Computer Science, not only do we have problems with granular psychometrics regarding competence in specific things, we now also encounter the problem of whether or not a student remembers the relevant content and procedures. The BS accredits what a student might have once known, not what they know now.

## Knowledge Gap Discovery

If a TLA wants to achieve higher-level goals, such as optimisation of learning itself, then it will need to first optimise the efficacy and speed of Knowledge Gap Discovery. In order to quickly build expertise, it is apparent that identifying and teaching the necessary metaphors to move forward is not just a boon to performance, but essential. Identifying knowledge gaps is difficult without modularised education, granularity in the modules, and reliable psychometrics for competence in those modules.

## Optimisation in Concept Learning and Explicit Memorisation

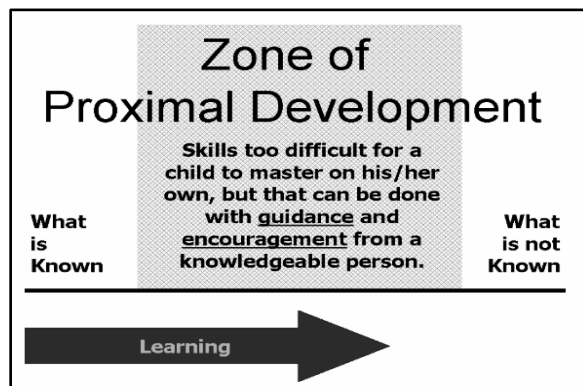
The reasons to optimise concept learning and explicit memorisation are obvious, the means to do so are not. The last 20 years of military research would suggest that the following methods produce impressive and reproducible results:

### Machine Assisted Distributed Learning/Personal Assistant

Allowing machines to assist in the scheduling and choice of content to review. In addition, pedagogical agents being the basis for this assistance and offering of support, referred to as him or her, makes significant improvements to learning.

### Handling Learning Breakdowns and Expert Support

“An Aristotle for every Alexander” was the phrase used in one report. In line with Lev Vygotsky’s theory on proximal development, a more knowledgeable other can greatly improve learning speed. The handling of what is known as **learning breakdowns** has been positively identified as a key indicator of classroom success. Learning breakdowns, as mentioned earlier in the document, can be defined as any time a student lacks the proper metaphors to move forward. If a tutor can “intervene” in order to help develop these missing metaphors in order to create a bridge between what is known and what is unknown, learning speed is significantly increased and the drop-out rate is reduced.



*Figure 1 - Vygotsky's Zone of Proximal Development*

### Meaningful and Multi-Perspective Engagement with Peers

In line with Jean Piaget’s cognitive development theory, independent, project-based exploration with peers and peer-tutoring can greatly improve learning speed. Renowned physicist Richard Feynman is noted for his “Feynman technique” which is to teach a peer (or at his suggestion, a toddler) in order to successfully refine the metaphors used to understand the subject while simultaneously identifying gaps in the technique-user’s knowledge. Working with peers helps expose students to

multiple perspectives on the subject and if paired with projects, will allow for exploration which enables what is known as depth of processing, a process that is fundamental in the construction of robust and stable memory.

#### Meaningful and Multi-Perspective Engagement with Material

As implied in the segment above, meaningful and multi-perspective engagement with material enables depth of processing. Non-project-based learning is meant to anchor the information long enough in order for it to be used so that it might be reinforced, if it's unused the memory will likely decay and if it doesn't, it'll likely be sterile and inflexible.

#### Concept Mapping and Gamification

Ralph Chatham's work and what came after has shown that gamification helps an enormous amount. The problem DARPA faces is that much of the attempts to gamify processes overshoot and misunderstand the meaning of the word game. For example, Crystal-Island!, a game meant to teach biochemistry, feels as though it was meant for elementary school students. Products must use the **Rosetta Stone Rule**; it should not feel out of place in a kindergarten classroom **or** a CIA desk office.

## Data Cataloging - Heuristically Relational Schemata

The lack of Heuristically Relational Schemata has been troubling the government for some time. Palantir has offered solutions to this, but with a massive price tag and only for pre-existing data that have their relations pre-established. There are no ML programs that can currently handle this task adequately, as

stated by one of the most informed individuals on the planet, the director of DARPA, second wave AI is simply not capable of dealing with these types of heuristics consistently and safely. **Wikipedia has been noted to do a better job at this than news-scrappers**, though they do it slower. Civilian crowdsourcing, as stated in a previous report, is of great interest as a solution.

## Detection of False Information and Bias in its Removal

As stated in the segment above, second wave AI is simply not capable of handling this problem. The Government needs a platform through which they or, as Rand Waltzman described, a whole-of-nation network, might detect and counter persuasion campaigns by threat actors.

## Centralised AI Capable of Human Heuristics

This is of interest across the DoD, IARPA, and DARPA as part of the government-wide initiative to develop third wave AI, as discussed in the previous segments.

## Inefficient Cultural Market

A Cultural Market can be defined as any market in which cultural signals play a dominant role, monies do not necessarily need to be a basis for exchange. Facebook constitutes a Cultural Market of content in which actors decide buy-ins (clicks) on cultural signals given to that content by peers (likes) and others as well as initial allure. Cultural Markets depend on wisdom of the crowd in order to be highly efficient. The Government has had a problem regarding the Cultural Market of social and behavioural research, the crowd has become remarkably unwise regarding determination of conflict of interest, integrity in defining



research as exploratory rather than confirmatory, and reproducibility.

## Using the New Perspective on the Market

Though some companies in the market are moving towards meeting some of these needs, and some are already working with the military directly, they do not meet these needs adequately as per DoD and DARPA literature. Being armed with this new perspective, a company can (1) tailor its products such that it meets these needs and know that, even if it targets a civilian market first, it has market validation in the long run. (2) A company can take advantage of the fact that the government has pursued and aggregated research with resources and at a scale that the private market cannot access or afford, respectively. (3) A company can announce that they are moving towards these well-defined targets and have a relatively good chance of attracting the interest of the Government's private investment cartel which is very capable of bringing companies of interest to market as quickly and efficiently as possible, at scale. Finally, (4) if a company can link the unresolved demands of the government to unresolved demands in the private market, the government's private investment cartel, and the company itself, have far more options at all stages of funding and growth.