

The Natural Approach: a traditional teaching method for achieving Quantum Literacy proficiency

Angelo Compierchio¹, Phillip Tretten¹, Prasanna Illankoon², Attilio Di Matteo³

1. Luleå University of Technology, 2. University of Moratuwa, 3. Comprehensive Institute - Lacedonia

INTRODUCTION & AIM

A reported John Von Neumann advice to Claude Shannon claim: “You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one really knows what entropy really is, so in a debate you will always have the advantage” [1]. In this view, entropy is just a statistical language context, just as mathematics is for Quantum Physics (QP). Hence, the ability to verbalize QP allow students to gain advantage through simplified comprehension and rich input into the QP symbolic language of resemblance. Nowadays, the completeness of QP is an active area of research that challenges teachers in communicating it to students with tuned inputs. Therefore, the aim is to incorporate a simpler ‘naturalistic’ approach for communicating Quantum Literacy (QL) educational goals.

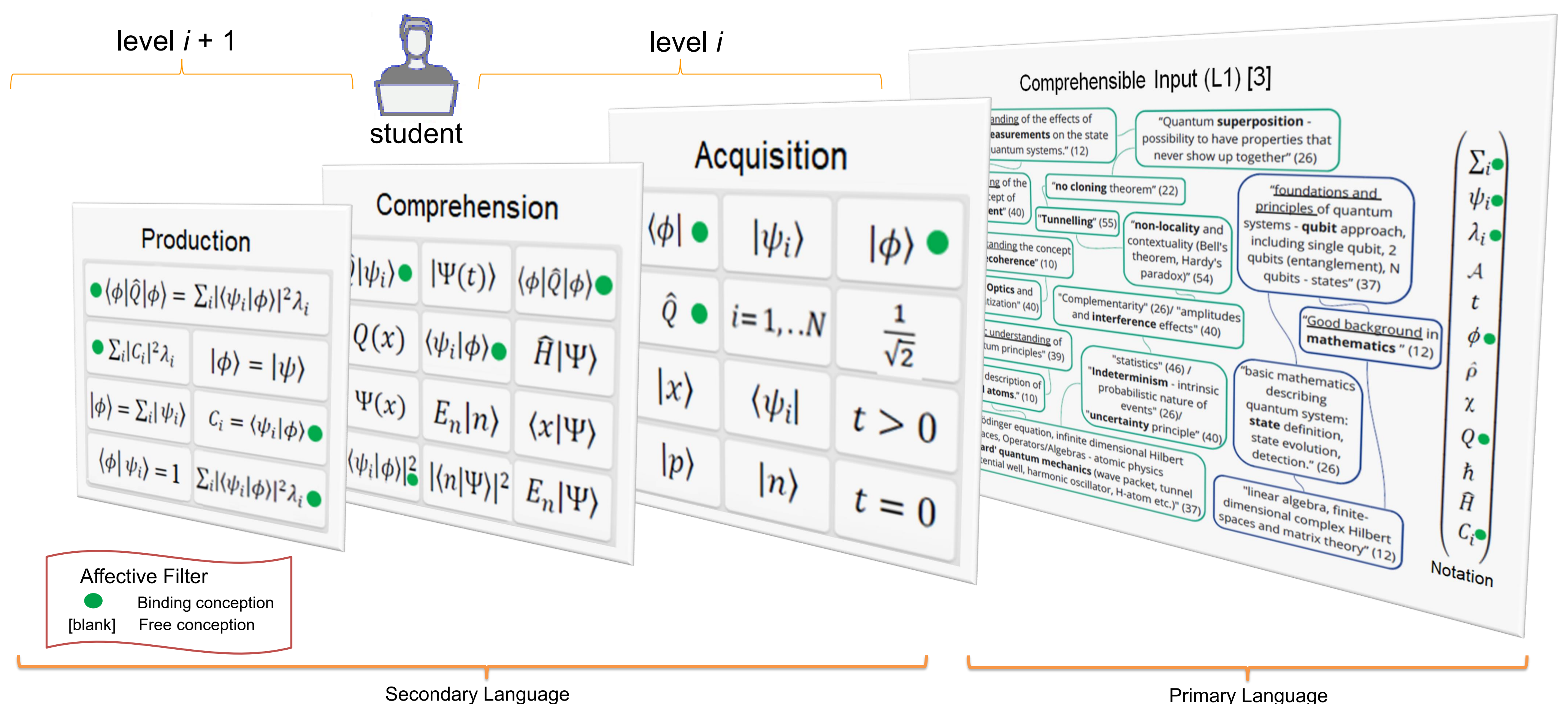
METHOD

Earlier efforts to include ‘naturalistic’ principles in teaching were exemplified by the Direct Method, which encouraged students to mimic the first language (L1) without translation. In the late 1970s, Tracey Terrell emphasized the same theoretical principle in studies of second language learning, which she elaborated through Stephen Krashen classroom practice. Their effort attained the *corpus domini* of the Natural Approach (NA). The NA theoretical foundation comprises Acquisition-Learning, Monitor, Natural Order, Input and the Affective Filter hypotheses [2]. In essence, this method parallels L1 with subconscious acquisition and conscious learning. In grounding NA in QL, lexicon symbols are key for the percept construct.

CASE STUDY

In this study, the teacher guides the problem enquiry with a built-in L1 input dimension. The case illustrates the implementation of the NA approach, where a student is asked to write an expression for the physical observable Q . Given a Hermitian operator for certain general state conditions, the correct answer is $\sum_i |C_i|^2 \lambda_i$. With comprehensible input, students can acquire competence with motivation and confidence to (level $i + 1$). With the acquired knowledge they learn to comprehend, monitor, and correct their free conceptions with adequate time and comfort. With production, they adopt a common language.

SYNTHESIS OF FINDINGS



CONCLUSION

The NA method split Quantum Literacy in two parts. On one hand, the theory and the silent influence from the L1 acquisition enhance the mathematical order of acquisition of the second language. On the other hand, the role of a second language in the classroom is only transitional, to help the student acquire further know-how from the outside world.

FUTURE WORK / REFERENCES

- Develop NA lessons design and practical guides with teachers.
- [1] Tribus, M.; McIrvine, E. C. Energy and information. *Scientific American* **1971**, *225* (3), 179-190.
 - [2] Krashen, S. D.; Terrell, T. *Natural approach*; Pergamon New York, 1983.
 - [3] Greinert, F.; Müller, R. Competence framework for quantum technologies: methodology and version history. *EC: Brussels, Belgium* **2021**.