ENHANCING LEARNING OF THINKING SKILLS: THE IMPACT OF PRIMARY SCHOOL YEAR EDUCATION

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Abstract

Today critical thinking has become central in mainstream education, as a broad and functional key competence for personal, social and work life. A taxonomy of critical thinking has been empirically elaborated for the skills of critical thinking through four main dimensions, which serves as the theoretical framework for the study. The value-added orientations for assessment that involve accurate measures for the cumulative effect of education, where learners are placed at the center to empowerment, is adopted. The research tradition of critical thinking tests usually focuses on assessing a thinking skills, which here are classification, problem solving and logical reasoning; this study aims to answer the research question on the impact of one year of education on these skills. To this aim, two samples of grade 5 and grade 6 Spanish students were surveyed through seven items on these three thinking skills. The results point out that the education of a school year has no significant impact on the three thinking variables. Finally, some consequences and proposals for enhancing the design and methods of assessment for thinking skills are discussed in order to gather new evidences on the central research question.

Keywords: critical thinking skills, enhancing learning, assessment of thinking skills, impact of mainstream education.

1 INTRODUCTION

Today critical thinking has become central in mainstream education, because it is broadly considered an important and functional key competence for personal, social and work life [1]. Several educational organizations and experts agree in suggesting the great value of thinking for education. The European Union proposed seven key competences and some transversal skills to achieve competencies [2]: critical thinking, creativity, initiative, problem solving, risk assessment, decision making, communication and constructive management of emotions. The OECD’s [3] skills and competencies for the 21st century in PISA involve the ability to think independently and develops in three dimensions, where research, problem solving, creativity, decision making, critical thinking and responsibility are the skills included in the dimensions. Further, many prestigious educational experts propose keys for learning that involve critical thinking as a common issue; for instance, Fullan’s 6 Cs competencies for deep learning include critical thinking, creativity, communication, collaboration, citizenship and character [4].

Just to a quick introduction, the Norris and Ennis’ definition of critical thinking is one of the most celebrated: “... reasonable thinking that is focused on deciding what to believe or do” [5]. Yet Norris and Ennis’ definition is short and simple, the literature has been prolific for definitions on critical thinking, each contributing to highlight some important aspects of critical thinking, though this multiplicity suggests scholars also disagree on a consensus definition.

Therefore, some scholars prefer approaching critical thinking through extensive definitions, which involve enumerating a set of higher-order skills compose for thinking. Fisher [6] proposes the following skills: identify the key elements of speech; identify and evaluate assumptions and implicit values; clarify and interpret ideas; judge the acceptability and credibility of assertions; evaluate the quality arguments; test your own conclusions; produce arguments; appreciate and interpret data and evidence; recognize logical relationships between propositions; understand and use language with clarity, precision and discrimination. Of course, some controversies about the differential relevance of skills rage the filed, yet some scholars agree to distinguish between basic, process and dispositional (values) skills [7].

Further, multiple educational programs have been settled and applied in schools for teaching thinking in the last decades [7]. Most of them still remain empirically untested to settle out their actual impact and thinking achievements [8]. Indeed, efforts have been made along the years to assess the effects...
of such complex and elusive learning, and some assessment tools have come into light, yet they are not exempt of controversies.

A taxonomy of critical thinking has been empirically elaborated from the dimensions of critical thinking included in 17 critical thinking assessment tools, which are much more unambiguous than authors’ definitions. Yet a set of critical thinking skills were drawn from 17 assessment instruments, were analyzed and interpreted by stating the equivalence of the different wordings and balancing the contributions of the different instruments and prioritizing the grouped categories [9]. Taking into account the relations of similarity or inclusion between these categories, the suggested taxonomy for the skills of critical thinking is formed by four main dimensions, which still split in different categories and is open to development.

CREATIVITY (generate ideas, conclusions)

- Ask good questions
- Observation (compare, classify)
- Analysis and synthesis (parts-everything, analogies, models)

REASONING AND ARGUMENTATION (justify prediction, implication, conclusion)

- Logical (deductive)
- Empirical (explain with data, information, evidence)
  - Inductive (generalizations)
  - Argumentation (abductive)
  - Statistical (probabilistic)
- Fallacies and Errors

COMPLEX PROCESSES

- Decision making
- Problem resolution

EVALUATION AND JUDGMENT (assessment of the thinking quality)

- Intellectual Standards (Clarity, Accuracy, Relevance, ...)
- Reasoning
- Actions (solutions, decisions, consequences, ...)
- Credibility of sources
- Identify Assumptions
- Communication (clarification of meanings)
- Meta-cognition
  - Self-regulation and self-reflection
  - Attitudes and affections (dispositions)

A key implicit idea in this theoretical framework states that the name critical thinking is foundational, thus it has the highest hierarchical level in the framework; consequently, this construct must be reserved for labelling the global construct. Further, the subsequent levels of the taxonomy depict the set of thinking skills of lower level categories, thus included in critical thinking.

Indeed, the taxonomy does not intend the different categories are totally disjoint or diverse from each other, on the contrary, as they all are thinking, the different categories may share different elements and be related to each other.

The value added orientations applied to educational research aim to measure the enhancement of students’ attributes (knowledge, skills, abilities, development, etc.) as a consequence of their learning experience along a period of time. Bennett [10] defined value added as what is improved about students’ attainments as a consequence of their education and Harvey [11] added students’ empowerment as critical, reflective, life-long learners. Thus, value added is an outcome-based assessment that is learner centered, makes teaching and learning visible and challenges the traditional paradigm of teaching.
The value-added orientations involve accurate evaluation plans to measure the cumulative effect of education, and are often used to assess educational institutions, principals, teachers, curricula, etc. However, most translations of value-added results in league tables or rankings are not deemed genuine representations of educational value added.

The most common method of setting students' value-added outcome involves measurement along two (or more) moments of the educational pathway. Value added is the difference between the final and the initial values that represent the increase in students' skills and knowledge over their tenure in school [12]. Thus, value added is student-specific and innately difficult to assess so that most attempts have relied on measurement of entry and exit grades or abilities using somewhat crude indicators. In spite of difficulties, the assessment of value-added lies at the core of any improvement-oriented approach to quality assessment and is the best way to assess student learning, but education has not yet committed itself to developing reliable measures of education.

Value added orientation means that learners should be both at the center of the learning process and at the center of the learning assessment processes, and this student-centered trait shifts the emphasis from enhancement to empowerment. Value-added measures offer a fairer assessment of students' progress by identifying performance above or below expectation, of the school's role by understanding what is working and of comparisons between different schools' performances.

This paper aims to analyze the results of five items with a short-text and figurative format that were answered by grade-5 and grade-6 primary students to assess the impact of the improvement of the learning of thinking skills during a school year education. The research question is: How much does the learning of thinking skills improve in the final year of primary education?

2 METHODOLOGY

The research tradition of critical thinking tests usually focuses on assessing a few thinking skills. Our assessment instruments for elementary students called "Challenges of thinking" evaluate some skills as classification, problem solving and logical reasoning.

This instrument adopts a free-culture orientation, which means that the elaboration of the answers does not entail any prerequisites or specific knowledge of school curriculum. In particular, the use of numbers and mathematical operations, which is a very frequent resource in the evaluation of thinking skills, is avoided. Further, the cognitive demand on students to achieve the correct answer to items is focused on the specific skill through presenting students' authentic cognitive challenges for thinking, which is independent of requirement or prior knowledge, but the basic comprehension of short and simple texts and pictures.

Summing up, the design and content of test items meet the following criteria:

- pose a thinking challenge, whose achievement is motivating or exciting for students.
- the cognitive demand of challenges aims to elicit the skill which is designed for, and
- the contents are easily readable, understandable, adequate and interesting for the age of the students they address.

A sample of students enrolled in grades 5 (187 students) and 6 (243 students) answered the same five items that were anchored in different tests applied to the sample of both grades to allow the comparisons. The thinking skills that were assessed through the five items are: classification (2 items), problem solving (1 item) and logical reasoning (2 item). One item on classification asks for three answers (one point each), while the remaining items display just one question. The scoring system assigns one point to the correct answers and zero points to wrong answers. Two of the items are displayed in the annex of this paper.

On the basis of the single item scores a set of dependent variables on thinking are defined for the thinking skills involved in this study, as the sum of single item scores across all five questions. The classification skill is the sum of classification items (range 0-4 points), the logical reasoning is the sum of two items (range 0-2 points), and the problem solving skill identifies with the item involved (range 0-1 point).

The comparisons of the scores will be evaluated using the statistical parameter called effect size of the differences, which measures the magnitude of the differences in a normal scale. The effect size will be computed to compare grade 5 versus grade 6 across all the variables, the item and the dependent variables.
3 RESULTS

In this section the results of the evaluation of the thinking skills by means of the common items answered by grade 5 and grade 6 students are presented. The presentation of results aims to verify the answer to the research question posed and is developed in three parts: the results for grade 5, the results for the grade 6 and the comparison between grade 5 and 6 to ascertain the impact of one-year learning on the skills.

3.1 Results for the grade 5

The item averages for the sample of students in grade 5 (n = 187) are displayed in Table 1. Most of the items display mean scores with intermediate difficulty indexes, close to the median of the range of scores, which is a good statistical result. The only exception is the item that measures problem solving, whose score is much lower and difficult.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Skill</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area _A (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,65</td>
<td>0,479</td>
</tr>
<tr>
<td>Area _B (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,63</td>
<td>0,485</td>
</tr>
<tr>
<td>Area _C (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,62</td>
<td>0,487</td>
</tr>
<tr>
<td>Images (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,47</td>
<td>0,50</td>
</tr>
<tr>
<td>One_face_square (range 0-1)</td>
<td>PROBLEM</td>
<td>0,26</td>
<td>0,438</td>
</tr>
<tr>
<td>John_pens (range 0-1)</td>
<td>LOGIC</td>
<td>0,38</td>
<td>0,486</td>
</tr>
<tr>
<td>Sara_book (range 0-1)</td>
<td>LOGIC</td>
<td>0,48</td>
<td>0,501</td>
</tr>
<tr>
<td>CLASSIFICATION (range 0-4)</td>
<td></td>
<td>2,37</td>
<td>1,540</td>
</tr>
<tr>
<td>PROBLEM SOLVING (range 0-1)</td>
<td></td>
<td>0,26</td>
<td>0,438</td>
</tr>
<tr>
<td>LOGICAL_REASONING (range 0-2)</td>
<td></td>
<td>0,86</td>
<td>0,779</td>
</tr>
</tbody>
</table>

The scores of the three variables that represent the three assessed skills also display intermediate difficulty scores, close to the median of their ranges; again, the lowest score corresponds to the problem solving skill.

3.2 Results for the grade 6

The item averages for the sample of students in grade 5 (n = 243) are displayed in Table 2. Again, most items display mean scores with intermediate difficulty indexes, with exception of the problem solving item, which is much difficult.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Skill</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area _A (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,50</td>
<td>0,501</td>
</tr>
<tr>
<td>Area _B (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,79</td>
<td>0,411</td>
</tr>
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<td>Area _C (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,67</td>
<td>0,469</td>
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<td>Images (range 0-1)</td>
<td>CLASSIFICATION</td>
<td>0,52</td>
<td>0,501</td>
</tr>
<tr>
<td>One_face_square (range 0-1)</td>
<td>PROBLEM</td>
<td>0,20</td>
<td>0,399</td>
</tr>
<tr>
<td>John_pens (range 0-1)</td>
<td>LOGIC</td>
<td>0,41</td>
<td>0,493</td>
</tr>
<tr>
<td>Sara_book (range 0-1)</td>
<td>LOGIC</td>
<td>0,49</td>
<td>0,501</td>
</tr>
<tr>
<td>CLASSIFICATION (range 0-4)</td>
<td></td>
<td>2,55</td>
<td>0,473</td>
</tr>
<tr>
<td>PROBLEM SOLVING (range 0-1)</td>
<td></td>
<td>0,20</td>
<td>0,399</td>
</tr>
<tr>
<td>LOGICAL_REASONING (range 0-2)</td>
<td></td>
<td>0,90</td>
<td>0,497</td>
</tr>
</tbody>
</table>
The highest score is reached in the second item of the classification skill, which is the easiest for the sixth graders.

3.3 Comparison between grade 5 and 6: the impact of one-year learning

Figure 1 summarizes the comparison of the item scores for the thinking skills that has been assessed in grades 5 and 6. As a tendency, the grade 6 scores are higher than grade 5 scores, although there are two exceptions: the area A classification item and the problem resolution item have lower scores in grade 6 than in grade 5.

![Figure 1. Comparison of the item scores for the thinking skills that has been assessed in grades 5 and 6.](image)

In spite of this trend to improvement, the magnitude of the differences observed between the two grades across the thinking variables are very small; the calculation of the effect size of the differences for each variable produces indices that all are under 0.10 score. Thus, the conclusion is that not only the differences are not statistically significant, but also that they are very small.

Consequently, these results do not allow to verify that learning along a school year between grade five and grade six produces an impact and an added value in the three thinking skills that have been assessed here. On the contrary, the results point out that the education of a school year has no significant impact on the three thinking variables analyzed in this study, namely classification, problem solving and logical reasoning.

4 CONCLUSIONS

This study was designed to verify the impact and educational value added of a school year of learning in grades 5 and 6 of elementary education. Seven items have been used to measure the added value of the impact of education on three critical thinking skills, such as classification, problem solving and logical reasoning.

In view of the results obtained, the answer to the research question must be categorical and negative: the education given to students in grades 5 and 6 does not have a significant impact on the improvement of skills classification, problem solving and logical reasoning.
However, this study has some limitations that stem from the design of the methodology, which opted out for the simultaneous application of assessment items to two different cohorts of students. Thus, according to pursue the confirmation for these results, research should address the same question draw new and accurate data and interpretations to improve the project design for the future. To this aim, new designs and methods must be taken into account, such as a year of follow-up with the same cohort of students.

First, the evaluation instrument is very short and, to some extent, unbalanced, in the sense that not all of the measured skills are represented, and by the same number of items. Thus, the best way to stimulate a valid and reasonable response is to lengthen the test to include other skills.

Second, the students who answered the questionnaire correspond to different cohorts of grade 5 and grade 6 who have responded questionnaire simultaneously. This issue is addressed through a work in progress that is planning to test the answer to the research question counting with a follow up of a group of teachers.

Further, the interest in evaluating some critical thinking skills is justified because they are transversal and cross-curricular to most learnings. Thus, the negative results presented here should raise stakeholders’ awareness on the difficulty to enhance learning along some current educational innovations, such as the competence, skill and deep learning orientations that are being advocated crucial for XXI century education.

Particularly, the debates on the innovation shift of school education from surface learning and traditional education to deep learning, competence and skill oriented education is involved. To sum up, it seems important the continuity of this kind of research to diagnose the impact of the school curriculum on thinking skills as it is decisive to provide evidences for the advancements yet contrasting the results through all the complementary designs and methods suggested above is also strongly recommended.

ACKNOWLEDGEMENTS

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REFERENCES


ANNEX. SAMPLE OF ASSESSMENT ITEMS

Sample item of classification

The following composition of images shows that all of them are similar to each other, with the exception of one image. Look carefully at the features they have in common to find out what the different image is.

Mark the letter of the image that is different from the others.

![Sample images](image_url)

Sample item of logical thinking

SUPPOSE YOU KNOW THAT: All John’s pencils are blue.

THEN, WOULD THIS BE TRUE?: At least some of John’s pencils are not blue.

a) YES It must be true.
b) NO It cannot be true.
c) MAYBE It may or may not be true. Not enough was said to be sure if it is "YES" or "NO".