

Key-competences in higher education as a tool for democracy

Le competenze-chiave nella formazione universitaria come strumento di democrazia

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Abstract

As the focus of teaching progressively moves from being transmissive to student-centred, under the beneficial pressure of the European recommendations, the debate on how to form and measure competences in students has become topical. This transformation was made necessary to nudge education institutions towards accountability, and to allow students (and their families) to make informed school choices. Large-scale achievement or cognitive tests were then developed by international organizations and administered in schools. The focus of the present paper is to provide empirical evidence that this process can be successfully embraced also by the higher education system. To this end we report data from several surveys in which ANVUR, the Italian public agency for the evaluation of universities and research institutes, administered the Test of Competence (TECO) to evaluate generic and disciplinary competences in first- and third-year undergraduate students. Using the value-added approach, we demonstrate that both types of competences can be formed by higher education institutions and that the university attendance makes a difference, especially for the disciplinary ones. The study qualifies TECO as a reliable tool for self-assessment of teaching effectiveness, to be used for evidence-based policies in higher education.

Keywords: character; cognition; higher education; personality; skills.

Abstract

Mentre l'obiettivo dell'insegnamento passa progressivamente dall'essere trasmissivo all'essere centrato sullo studente, grazie anche alla pressione delle raccomandazioni europee, il dibattito su come formare e misurare le competenze negli studenti è andato intensificandosi. Questa trasformazione si è resa necessaria per spingere le istituzioni scolastiche verso una maggiore responsabilità del proprio operato e per permettere agli studenti (e alle loro famiglie) di fare scelte informate. Sono stati pertanto sviluppati dei test cognitivi su larga scala da organizzazioni internazionali, che sono stati poi somministrati nelle scuole. Il punto centrale del presente lavoro consiste nel fornire prove empiriche che questo processo può essere adottato con successo anche dal sistema universitario. A tal fine, riportiamo i dati di diverse sperimentazioni in cui ANVUR, l'agenzia pubblica italiana responsabile della valutazione delle università e degli istituti di ricerca, ha somministrato il Test di Competenze (TECO) per valutare le competenze generiche e disciplinari negli studenti universitari del primo e del terzo anno. Utilizzando l'approccio del valore aggiunto, siamo in grado di dimostrare che l'università può formare entrambi i tipi di competenze e che la frequenza universitaria può fare la differenza, in particolare per le competenze disciplinari. Lo studio qualifica TECO come uno strumento affidabile per l'autovalutazione dell'efficacia dell'insegnamento e può informare scientificamente le politiche universitarie.

Parole chiave: carattere; cognizione; formazione universitaria; personalità; competenze.

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1. Introduction

Scholars and policy makers have long debated about the meaning of competences (see Benadusi & Molina, 2018, for a recent review). Undoubtedly, this construct intercepts several fields, from economics to psychology, pedagogy and sociology, and seems to mean different things to different people. Its nomadic nature does not necessarily imply that the concept of competences is exogenous to education. For instance, the pedagogical activism by Dewey is often cited in defence of the endogenous origin of competences within education. However, the early association between competences and the labour market in the Seventies of the last century might explain why many critics argued that the rise of competences in schools and universities reflected an attempt to impose the logic of the market on education. Moreover, a defensive attitude towards the concept of competences has grown with the large-scale achievement or cognitive tests promoted by international organizations, especially in schools. For instance, the International Association for the Evaluating of International Achievement (IEA) has endorsed several studies since the late Fifties, assessing different competences, including reading, science, physics and civics, in pupils of different age (e.g., The Six Subject Survey, the Progress in International Reading Literacy Study - PIRLS, the Trends in International Mathematics and Science Study - FIMMS and TIMSS, and the International Civic and Citizenship Education Study - ICCS). The Organisation for Economic Co-operation and Development (OECD) eventually stepped into this process with the massive Programme for International Student Assessment (PISA) that assesses the competences (e.g., reading, math, science, problem solving, financial literacy) of 15 year-old students, independently of the class attended. All these programs left the adults' competences unexplored until OECD launched the Programme for the International Assessment of Adult Competences (PIAAC), that investigates the level of literacy and other competences in 16- to 65-year-old individuals, and the Assessment of Learning Outcomes in Higher Education (AHELO), a feasibility study completed in 2013, that was intended to establish whether an international survey could be created in higher education to evaluate learning outcomes of generic and more discipline-specific competences. Unfortunately the project failed through for lack of the necessary support from OECD countries to blow it as a full survey.

1.1. Cognitive and non-cognitive competences

As mentioned above, the cognitive competences have generally been measured by means of achievement tests. Such tests have been employed by schools and universities as a self-assessment tool, to improve the teaching programs that failed to lead to satisfactory results, but also to meet the institutions' demand for accountability. In this view, high achievement scores are held to reflect good cognitive competences which, in turn, are expected to lead to better career and life (Cappellari, Castelnovo, Checchi & Leonardi, 2017). This association between achievement scores and life outcomes has significantly been strengthened by the theory that cognition is at the basis of all mental abilities. Furthermore, the success of these tests has been facilitated by their being relatively easy to be administrated and their reasonable cost (Heckman & Kautz, 2014). In contrast, the importance of assessing individuals' non-cognitive competences has become apparent in recent years when it has been demonstrated that the character, operationally defined as personality traits, can account for life outcomes (Heckman & Kautz, 2014).

There is some available evidence in support of an alleged influence of non-cognitive skills on academic and work outcomes. Recently, for instance, Borghans, Golsteyn, Heckman and Humphries (2016) analysed a large set of data on cognitive and personality measures derived from four different datasets². These authors compared three indicators normally utilized as a proxy for cognition – an Intelligence Quotient (IQ), obtained from the Raven Matrices, scores on standardized learning tests (Differential Aptitude Test - DAT) and school grades - to verify the predictability of cognitive and personality scores. Even though the IQ and personality measures showed some variability across databases, consistent patterns were observed: the correlations between IQ and grades or achievement tests, or between grades and achievement tests are not very strong; however personality was found to positively correlate with grades and achievement test scores. Interestingly, personality turned out to be a powerful predictor for most life outcomes, while grades and achievement test scores were more predictive of adult outcomes than IQ.

Furthermore, they argued that non-cognitive skills are more malleable than IQ because some programs aimed at stimulating desirable aspects of character are more successful than those aimed at increasing IQ. However, the intervention programs to which the authors refer have relatively short-term follow-up, are not homogeneous in the definition of outcomes, and are usually addressed to specific demographic groups so that it is very difficult to generalize their findings (see also Heckman & Kautz, 2014). Another study that suggests some malleability of non-cognitive skills if provided by Jokela, Pekkarinen, Sarvimäki, Terviö and Uusitalo (2017). These authors analysed the standardized personality test scores given to 79% of males born in Finland between 1962 and 1976 (n = 419.523) and demonstrated how personality traits that predict higher economic income in life grow in the period considered. This “Flynn effect” of personality parallels the better known effect for cognitive abilities (an increase of 0.2 -0.6 SD over a period of 15 years). Although it is not clear what precisely causes the Flynn effect, trends in demographic variables (family composition, parent education level etc.) seem to explain two third of the increase in cognitive skills and one third in personality. One shortcoming of Jokela et al.’s (2017) study is that the sample included only male participants. Despite some limitations of the above mentioned studies, the capability of personality traits to predict educational and life outcomes and their potential malleability are promising.

2. The role of ANVUR

In the following we will introduce the TECO (TEst of COmpetence) project, promoted by ANVUR (Agenzia Nazionale per la Valutazione del sistema Universitario e della Ricerca), the Italian Agency for the evaluation of universities and research institutes, and we will review the actions carried out to implement it. With the Presidential Decree which founded ANVUR (D.P.R. n. 76/2010 art. 3), and subsequent decrees (in particular the Appendix E of D.M. n. 987/2016, now exceeded by D.M. n. 6/2019) issued by the Italian Ministry of Education, University and Research (MIUR), ANVUR was given the mandate to develop indicators about the students’ learning outcomes and their employment rates, as part of the teaching evaluation scheme that includes self-assessment, periodic evaluation, and accreditation of study programmes and universities (called AVA). These norms are in line with the Recommendations 2006/962/CE of the

² In all but the first dataset, the data concerning the outcomes of individuals in adulthood are also provided.

European Union (EU) such as those promoting the eight key-competences for citizenship and permanent learning, first launched in 2006 (see also the Recommendations issued in 2018), thus conferring to this construct a primary role over knowledge, skills or aptitudes. They also shortened the distance between the Italian education system and the other institutions of the European Higher Education Area's (EHEA) countries, that increasingly promoted a student-centred learning more centred on competences (ESG, 2015).

The key questions, then, are (i) whether such competences can be formed in higher education and, in positive case, (ii) how they can successfully be measured. The OECD (2017) report has highlighted that in Italy the match between competences and the tertiary education is far from being perfect, and that in particular the literacy e numeracy scores of Italian graduates are far from being satisfactory (OECD, 2013). This competences gap has also a negative impact on the labour market, especially if we consider that 44% of the graduates, who are employed a year after they completed their studies, state that competences are very relevant for performing the job they are in (AlmaLaurea, 2017). The analysis of the competences acquired by university students can therefore represent a fundamental contribution to the monitoring and improvement of the teaching quality. These are the premises that led ANVUR to develop, among its many activities, the assessment of competences as a proxy for the learning outcomes (Turri, Asquini, Squarzony & Refrigeri, in press).

3. Main features of TECO

In 2012, with the aim of evaluating the generalist competences acquired during the university course, ANVUR embarked on a new project about the evaluation of Italian undergraduates' learning outcomes through the CLA+ test, produced by the Council for Aid to Education (CAE). The test contains two main components: a performance task, whereby students are asked to write a solution to a problem supporting it with evidences, and a series of selected-response questions. The CLA+ is meant to measure the university students' performance on analysis and problem solving, scientific and quantitative reasoning, critical reading and evaluation, and critiquing an argument, in addition to writing mechanics and effectiveness. In Italy was administered twice in collaboration with 12 and 24 universities in 2013 and 2015, respectively. This first experience bared several shortcomings among which a bias in the selection of participants, a weak correlation between raters and between open and closed questions, as well as the high costs of the entire procedure (Ciolfi, Damiani, Delli Zotti & Sabella, 2016; Damiani, Agrusti & Ciolfi, 2016; 2017). Thus, in 2016 the Agency revised the whole project, including the domains of competences, the methodology and trials for both generic and disciplinary competences. With this new TECO project, ANVUR accomplishes the mandate to create the indicators that can be used to improve the teaching quality and outcomes. To account for the role of universities in developing or maintaining students' competences, the value-added approach was adopted, whereby both the competences of ingoing (first-year students) and outgoing (third-year students) first cycle university students are assessed. To date, two branches of TECO have been developed: TECO-T, where T stands for *trasversale*, i.e. transversal the Italian word for generic, and TECO-D, with D standing for *disciplinare*, i.e. disciplinary.

4. Generic competences of university students

Literacy and *Numeracy* are the first two generic competences that have been assessed within the TECO-T, while for two other areas the design process is nearing completion. In particular, the frameworks of *Problem Solving* (see ANVUR, in press, for a detailed presentation of the framework), and *Civics* have already been defined, with the items of the former being validated in Spring 2019. The generic competences can be developed by undergraduates during their university career, independently of the specific course undertaken, and as such can be compared between different courses of study. By applying the *value-added approach*, each educational institution can be evaluated not only on the basis of its students' absolute results but also, and more interestingly, with respect to the change occurred from the initial conditions.

Literacy items are meant to evaluate the undergraduates' levels of understanding and reflecting competencies on a text with a generic content – that is a content that cannot be associated to any specific course of study or disciplinary area. This test contains two types of items: the former type of items require participants to complete 10 closed-answer questions after reading a text, and in the latter they have to complete a short text with 20 words that are missing (Cloze test), for a total of 30 items. Numeracy items assess undergraduates' levels in logical thinking and solving quantitative problems, using a short text that includes graphs and tables, followed by five questions, an infographic followed by five questions, and 15 short logical reasoning questions, for a total of 25 items.

The items of both Literacy and Numeracy tests have been produced *in house* by the Agency, in collaboration with academic experts, and have been administered in pilot tests in 2016 and early 2017, with respectively 854 and 1460 students who performed the computer-based tests in dedicated rooms at their home universities. The whole procedure was remotely controlled by CINECA, the interuniversity consortium that offers support to the research activities through supercomputing and its IT applications. Five universities were involved in either occasion, and the time window defined by ANVUR for test administration was approximately two weeks.

4.1. Main results of 2016 and 2017 surveys

The item analysis of the first trial survey (carried out in 2016, and involving only third-year undergraduate students) demonstrates that indeed the Literacy and Numeracy items tap on specific competences, reflect different levels of difficulty, and discriminate the most competent students from those who are less so. In the second trial survey (carried out in 2017), only minor revisions were operated following the results of the item analysis, and both first-year (enrolled in 2016-2017) and third-year students (enrolled in 2014-2015) from four macro disciplinary areas (Science, Humanities, Social, Health) performed Literacy and Numeracy tests. As long as the test participants can be considered as representative of their populations, we can read these samples as pseudo-panels and interpret the results in terms of value-added.

The test scores were calculated on all the participants' responses using the two parameter Item Response Theory (IRT) model, and standardized on a scale with a mean of 200 and a standard deviation of 40. The mean difference between first- and third-year scores turned out to be significant only for Numeracy, with first-year students scoring above the mean (204.45), while the third-year students scored significantly below it (198.38). Conversely, the same students' scores on Literacy leaned around the mean, with the third-year students showing a slight improvement. Moreover, the students' characteristics (i.e.,

type of high school attended, final score, gender, and socio-cultural status) and their academic career also influenced the test results, with differences depending on the disciplinary macro area (Figure 1).

Literacy. When literacy results were analysed according to the disciplinary macro areas, students from science and social courses scored higher, although not significantly, on the third-year compared to the first-year, while humanities and health students showed the opposite tendency, with third year students scoring on average more poorly than first-year. Moreover, students from social science courses scored higher than other students, with first-year students showing on average only a trend, while third-year students scored significantly higher than those from humanities and health programmes.

Numeracy. Overall, third-year students scored significantly higher on numeracy than first-year students, except for the third-year humanities students, who performed significantly more poorly than all the other students. Within the science area the first-year students tended to perform better than the third-year students. Moreover, the social sciences students scored higher than the humanities and health students irrespective of the year considered, but also of the first-year health students.

Disciplinary macro area	Year	Literacy			Numeracy		
		Mean	Std. Err.	Freq.	Mean	Std. Err.	Freq.
Science	1	198.01	29.439	148	204.17	31.547	148
	3	203.63	35.278	119	210.71	34.409	119
Humanities	1	195.98	36.691	72	190.50	39.972	72
	3	193.94	38.649	106	174.88	34.766	106
Social Sciences	1	205.36	24.636	256	209.65	24.913	256
	3	210.37	29.809	211	205.50	28.527	211
Health	1	198.91	21.772	298	203.49	20.076	298
	3	195.62	28.084	250	196.47	26.551	250
Model	F	3.72***			11.79***		
Year	F	7.51***			19.77***		
Disciplinary macro area	F	3.33			5.05**		
Interaction (<i>year*disciplinary macro area</i>)	F	1.30			3.18**		

Figure 1. Factorial ANOVA: Literacy and Numeracy*Disciplinary macro area and year.

5. Disciplinary competences

Disciplinary competences are defined as being strictly linked to the specific education and training offered by a given study programme and can therefore be compared only among courses of a similar content. The TECO-D is mainly under the responsibility of the academic communities who develop the test, while ANVUR supervises their activities and provides them with dedicated methodological and technical support. This initiative is

a development of an earlier experience that was launched when the Agency was established and successfully led to some results only in the science area (Crescenzo et al., in press).

The new impulse to the TECO-D has been provided by the health profession programmes whose students' disciplinary competences have been evaluated for several years using Progress Tests (i.e., a closed set of identical questions referred to contents of different health professions, in order to measure the growth in knowledge of the students over years of attendance). In particular, ANVUR offered technical and scientific support in the process of validating the Progress Tests, by analysing the already available data (from the tests already administered) and returning to each disciplinary group a technical report in which potential methodological problems are highlighted. Thus, each disciplinary group has been able to emend individual items and/or the test structure considering the methodological comments provided by the Agency, resulting in a more effective test.

A further objective is, indeed, to standardize the timing and mode of administration for the tests within the TECO-D project. This procedure was undertaken for the progress tests used by the nursing, physiotherapy and medical radiology study programmes, and led to some methodological improvements (reduction in number of items, excision or revision of problematic items, etc.). Then, from late 2017 until early 2018, the TECO-D of these three study programmes was delivered to about 12.500 students from 27 Universities³. In the next section the main results will be summarized.

5.1. Results from the 2017-2018 survey

Overall the response rate within the participant universities was 38.9% (9.382 students) for nursing, 65.3% (1.757 students) for physiotherapy, and 70.3% (901 students) for medical radiology. This survey is by far the largest assessment of university students' competences accomplished in Italy to date.

In addition to the TECO-D, the same participants performed also the TECO-T. Here we will focus on the results concerning the associations between the tested competences, the characteristics of students and the university educational path. As for the 2016 and 2017 surveys, the test scores for Literacy and Numeracy were calculated on all the participants' responses, while the disciplinary test scores were calculated separately for each test.⁴

The correlation between the generic and disciplinary competencies' scores, for each enrolment year, is significant but tenuous (Figure 2). It is worth noting that the number of CFU (Crediti Formativi Universitari), corresponding to the European Credit Transfer System (ECTS), correlates more strongly with the disciplinary test scores than with the generic competencies, while for the average grades the opposite is observed, as they correlate more with the generic competencies' scores.

³ A total attendance of 12.510 students, of whom 3.993 (31.9%) carried out the paper and pencil version of the test rather than on the TECO online platform.

⁴ In all cases a two parameter IRT model was used and scores were standardized on a scale with mean 200 and standard deviation 40.

Year	Physiotherapy				Nursing				Medical radiology			
	Lit.	Num.	Teco-D	CFU	Lit.	Num.	Teco-D	CFU	Lit.	Num.	Teco-D	CFU
1	Num.	.212*** 580			.373*** 4542				.356*** 328			
	Teco-D	.048 580	.162*** 579		.126*** 4395	.115*** 4389			.163** 309	.132* 309		
	CFU	.106* 584	.106** 581	.040 581	.109*** 4551	.084*** 4543	.029* 4397		.068 329	.127* 329	.047 310	
	Average grade	.119 109	.030 108	.093 107	.080 109	.167*** 1124	.125*** 1123	.006 1093	.017 1125	.019 49	.502*** 49	-.170 49
2	Num.	.347*** 512			.374*** 2080				.309*** 219			
	Teco-D	.264*** 513	.244*** 512		.125*** 2074	.242*** 2071			.162* 219	.236*** 217		
	CFU	.076 513	.120** 512	.035 513	.073*** 2087	.121*** 2080	.224*** 2075		.081 221	.071 219	.265*** 219	
	Average grade	-.029 506	-.080 505	.242*** 506	-.049 506	.067** 2061	.059** 2055	.253*** 2049	.26*** 2062	.157* 218	.119 216	.203** 216
3	Num.	.191*** 658			.375*** 2732				.337*** 350			
	Teco-D	.251*** 650	.307*** 649		-.012 2718	.132*** 2713			.292*** 350	.392*** 350		
	CFU	.080* 659	.040 658	.318*** 650		-.047* 2739	.024 2732	.400*** 2719	.060 350	.022 350	.286*** 350	
	Average grade	.179*** 657	.100** 656	.274*** 648	.076 657	.096*** 2720	.131*** 2714	.220*** 2699	.220*** 2720	.172** 347	.082 347	.349*** 347

Figure 2. Correlation: Literacy, Numeracy, TECO-D, number of CFU and average grade; correlations, sig., N.

Regarding the disciplinary competences, while the presence of effects attributable to students' incoming characteristics (such as gender or diploma grade) is limited, the variables related to the university path have the most consistent and significant effect on disciplinary competence scores (Figure 3).

Results showed that the Literacy and Numeracy scores are positively affected by the year of enrolment, despite the link with several other students' characteristics. Moreover, Numeracy scores are strongly effected by gender, age, diploma type and grade, but they are also modulated by the university education received (Figure 3).

		Generic competences		Disciplinary competences		
		Literacy	Numeracy	Physiotherapy	Nursing	Medical radiology
Year	2 year / 1 year	2.662**	5.803***	46.664***	45.304***	26,518***
	3 year / 1 year	6.529***	7.737***	70.948***	65.960***	59,300***
Gender	Female / Male	-4.985***	-14.790***	1.490*	0.295	-3,895
Age	20-21 / under 19	-0.778	-2.511*	9.149**	4.547***	11,365*
	22-23 / under 19	-0.239	--6.070***	12.194***	4.538***	14,367**
	over 24 / under 19	-3.568**	-12.767***	11.996***	4.538***	10,948*
Secondary school Diploma type	High schools / Technical schools	7.643***	8.207***	-0.908	1.911*	-0,803
Diploma grade*	High / low	6.410***	7.331***	4.306	7.319***	9,586***
Social-cultural status **		0,807	1.305**	0.444	0.271	-1.127
Constant		196,099***	205.822***	148.59***	165.465***	159.855***
N		10.957	10.929	1.616	8.312	830
R ²		0,0229	0.0540	0.6139	0.5136	0.5097

*Diploma grade: "Low" = 60-84, "High" = 85-100.

** Social-cultural status index, inspired to the ESCS (Economic, Cultural, and Social Status) used in the OCSE-PISA reports (even if without the home possession dimension). It is obtained using a principal component analysis on the parents' higher occupational status (scored according to Ganzeboom & Treiman, 1996) and the parents' higher number of year of instruction (the proportion of variance explained by the extracted component is 70.7%).

Figure 3. Regression Models: Literacy, Numeracy, TECO-D * year, gender, age, diploma and diploma grade, social-cultural status; coefficients, N, R-square.

6. The strengths of the TECO-D

This program allows each disciplinary area to promote a shared definition of its core contents, in agreement with the Dublin Descriptors. If these premises are met, then it should be possible to develop dedicated disciplinary tests whose results at national level can be used by study programmes as benchmarks for self-evaluation purposes, thus allowing the exploration of eventual comparisons within the same university or across different universities. As a last point, ANVUR warrants a certified⁵ administration and data collection of the tests via CINECA.

Following the health profession groups (to date seven different curricula are involved in the project), other disciplinary groups (i.e., philosophy, pedagogy, psychology and humanities) have been constituted and are now following the several steps necessary in order to design and validate their tests. Such steps include the definition of the Final

⁵ The Quality Management System of CINECA is in compliance with the international standard ISO 9001, while its Information Security Management System is in compliance with the international standard ISO 27001:2013.

learning objectives (Obiettivi Formativi Finali - OFin) of the study programme, that is the competences that an undergraduate of particular curriculum should have achieved, according to what is stated in the Annual programme statement (SUA - Academic Programme). After having identified the Ofin by mutual consent, each group should identify the Specific learning objectives (Obiettivi Formativi Specifici - OFS), in conformity with the five Dublin Descriptors. The output of this sequence of activities is the design of a disciplinary test that will then be employed to evaluate students' core competencies as defined by each disciplinary group.

7. Discussion and conclusions

We began the project by asking ourselves whether competences can be formed in higher education. The value-added approach adopted in our surveys allows us to answer affirmatively to this first question, though differences can be observed depending on whether the generic or the disciplinary competences are considered.

As for the generic competences, the item tests used by ANVUR for assessing Literacy and Numeracy in university students tap on different levels of difficulty and discriminate between students' abilities to perform the test. The results on Literacy and Numeracy tests are influenced by the initial characteristics of the students and they can vary depending on the disciplinary macro area (2016-2017 survey). Of particular concern is the negative attendance gradient of Numeracy performance in the humanities macro area: the third-year students scored lower than the first-year students, possibly suggesting that students' quantitative competences are impoverished if study programmes do not maintain them to some extent. Moreover, the vulnerability of Numeracy competence is apparent also in the 2017-2018 survey, whereby the nursery students' scores seem to pay a greater toll to the initial characteristics, even in presence of a general improvement of the health profession students, due to university attendance. The findings concerning generic competences deserve to be further explored in order to better understand the contribution of students' characteristics and other possible intervening factors, and to eventually generate specific *ad hoc* actions to enhance students' performance.

As to the disciplinary competences, the critical finding is that university attendance makes the difference: indeed the number of ECTS correlates significantly more with the disciplinary competences than with the generic ones, and the effects of students' initial characteristics are minor.

Data as those discussed here can serve as a tool for self-assessment of teaching effectiveness and can feed evidence based policies in higher education.

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