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Importance of Non-cognitive skills in education context and development of measurement survey instrument for non-cognitiveskills Assessments.

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Abstract:
"Education" is a longitudinal process extended over a normal period of 10-15 years; especially in theera of technology one has to be lifelong learner. "Educated Person" is the product of this education process; which expected to be holistic in terms of professional, personal and social dimensions of individuals. Hence cognitive and non-cognitive skills development in individuals is basic requirement of the education. Paper highlights need of non-cognitive skill development and its importance.
In order to measure cognitive aspect of learners there are well established methodologies but non-cognitive aspect is still a grey area from measurement and development point of view. Hence the second objective of the paper is to establish measurement process of non-cognitive skills as latent variable. Survey based instruments are normally used for such measurement; but the issue with long questionnaires leads to unreliable data captured through respondent as they do not respond genuinely. This leads to survey data is not real reflection of the respondent. Hence how we make reduction in long questionnaires without losing the objective by statistical means is expressed in the paper with example.

Introduction:
About 2000 years ago the great philosopher Socrates stated very broad but sensible definition of the Educated Person which stand even now in this technology based era. He defined the educated beingis the one who manage well the circumstance which they encounter day by day and who can judge situations appropriately as they arise and rarely miss the suitable course of action. Long back Winston Churchill stated "*the first duty of a university is to teach wisdom not trade, character not technicalities*". Education policy maker, academicians also emphasis need of outcome based, broad based education as specially in professional education like management, engineering, medical science, legal, finance etc.
Considering all above views; education is a longitudinal process which convert row kids to matured professionals who is capable to handle various situation in his professional as well in personal life. Hence this process has to be holistic one which not only develop cognitive but no-cognitive aspect of individuals. As an educated person who acquired knowledge of particular discipline is not enough;if his or her skill set which are only cognitive which can enable he or she to earn but true success of life not achieve only with this aspect. Educated mean a far reaching aspect associated with the person;who is equipped with not only cognitive skills but non-cognitive too. The second enabler has far moreimpact on personal, interpersonal and social context.
In spite of these proven facts, unfortunately due importance is not given to Non-cognitive skills in educational system. Various research done in this domain of education process leads to the conclusionas the non-cognitive skill should be an explicit pillar of education policies. Literature review prominently demonstrate as there is inter dependence between cognitive and non-cognitive skills. Inculcating Non-cognitive skills enhance students' performance in terms of mathematic, reading andwriting skills. Non-cognitive skills are very vital for all around development of individual which is one of the major outcome of the schooling.[1]
Even though socio-economic status, family culture does influence in upbringing of child and it's overall mental development. Education can play vital role in this processes of upbringing and overall holistic development of a person.[2]
Definition Non-cognitive skills:

"These are patterns of thoughts, feeling and behavior of the person" (Barghan al. 2008). These skillsare malleable and can be refined or developed in life time (Bloom 1964). There are many synonyms for these skill as soft skill, behavioral skill or personality traits, socio-emotional skills etc.

Literature review:

As per Economics Policy paper published by Economic Policy Institute, Washington DC in 2014; there is no concrete list of non-cognitive skills and its area of exploration for researchers. Another literature which researchers prominently referred is "The impact of non-cognitive skills on outcomes for young people Literature review", 2013 by Institute of Education, University of London. The key findings of the review are as followed and further research work is needed as per paper.[9]

- School should promote Leadership, coping skills, and pupils' engagement in their students but there is lack of substantial evidences to prove causal effect of Non-cognitive skills on outcomes. Hence more experimentations required.
- It is noticed as some non-cognitive skills like 'grit', 'self-control' have strong correlation with student's outcomes but these are more stable personality traits and not that malleable one.
- This review claimed chat there are many studies which define and measure non-cognitive skills in incongruent means, assess them in isolation and take into consideration only short- term outcomes. Hence it is the urgent need to carry out research in this domain to explore how skills can be transferred between areas of a student's personal life and how it can be sustained in the long run for their professional and social life.

The review of this institute state as there are still significant gaps in the evidence base which are as followed:

1. As most of the studies so far have used correlational data so there is little confidence about the relationship between non-cognitive skills and later outcomes to be causal one. Hence rigorous experimental methods need to be developed in this domain.
2. There are very few studies so far which assess the long term impact of Non-cognitive skills; secondly there is little understanding regarding the extent to which non-cognitive skills are 'changeable' or how effective is particular training to bring these changes.
3. As of now there are many standardised instruments to assess cognitive skills and academic abilities of students but there is not one single measure of non-cognitive skills and researchers need to work in sync to make a common agreement how non-cognitive skills should be definedand measured.
4. It is observed as many non-cognitive factors are inter-linked; but most studies have done non-cognitive skills exploration in isolation. There is no conclusive evidence which highlight a one particular skill improvement which prominently facilitate attainment across all domains of academic, professional and social dimensions of a student.

Over all most of the literature reviews insist on to identify key competencies that can be modified Which are learnable, adaptable and effective in terms of positive outcomes in children as well as adults who go through formal educational process.

This Literature review have identified as potential key non-cognitive skills of children and young people which are listed as: [9]

1. Self-Perceptions 2. Motivation 3. Perseverance 4. Self-Control 5. Metacognitive Strategies 6. Social Competencies 7. Resilience and Coping 8. Creativity

Effect of on-line education during Pandemic:

In context on online education which was enabler for education process even during total lock downfor pandemic. The technology come to rescue our education system and we could manage to go alongwith online teaching learning experience and evaluation process. But there are inherent side effects observed which are majorly listed as:

- Social isolation
- Effectiveness of teaching – learning is subjective to learner's motivation and sincerity.
- Lack of communication skills
- Evaluation process is questionable and results are unrealistic.
- It loses on humanly factor

- It is not a suitable for practical oriented programs like Engineering, Medical.

All the above listed concerns are related to non-cognitive aspect only.

Measurement of Non-cognitive skills:

After realizing importance of Non-cognitive skill; next objective is how to measure and enhance the same in students. Research so far not very clear about which exactly skill set which matter from student's point of view and how to measure them. Even though some researchers claim as that the only feasible way of measuring Non-cognitive skills is by capturing student's beliefs and mind set through self-reported questionnaires (Kautz et al.,2014) but others raised a concern about the validity of self-reported measures and reference bias. In above literature review one of the major gap as stated by the literature review by Institute of education is as most the studies so far are short terms and in isolation and there are significant gaps in evidences. Secondly, there is no proper instrument to capture the data to establish relation of NC skills with respective outcomes.

In this context, researchers have already given some approaches which can be deployed in computerized learning management system in their prior paper presented in Scopus conference and subsequently published in IEEE explore. In this paper research would like to elaborate on next level of abstract thinking with elaboration on implementation. [6]

Over all research in social sciences adapt survey instruments to assess various behavioral and mental aspect of respondent. It is simplest to implement and effective means of assessment.

Researchers notice in their literature reviews as ; for each trait there are questionnaires developed by various domain experts, researchers and they state their validity in their paper; but most of questionnaires are too lengthy and hence not practicable especially when it is multi-trait assessment.As if the survey instrument is lengthy the respondent gets bored and answer them without involvement which lead to unreliable data capturing. Hence it is very crucial to reduce survey instrument without losing the objectivity. Rest of the paper give an approach to reduce instrument statistically.

Traditional survey instrument based approach:

In this approach we identify the Non-cognitive skill that we are interested to explore; these skill is a construct or directly unobservable variable or latent variable. For example, self-motivation, Anxiety, self-control etc. are few of the constructs.

There are two type of construct 1. Reflective 2. Formative.

In type 1; it incorporating observed variables as questions or items which are reflection of the construct within the respondent as responses on Likert scale of 5 or 7. In this case the direction of causality is from construct to items and all indicators are highly correlated one. Items are like consequences.

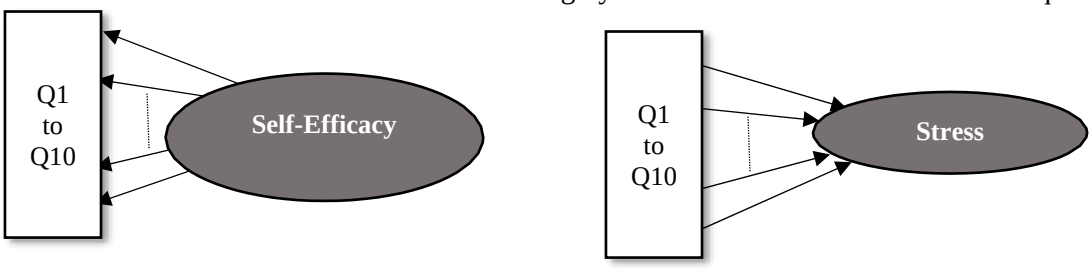


Figure 1.

In type 2, items form the construct which are not expected to be correlated and the direction of causality is from item to construct. Items are like causes. Hence identification of each type relevant study of the same is important in given context.

Next step is to carry out literature review for the scale developed by various researchers for this particular construct and identify most suitable set of questioner. Most of the scale developer specify in their paper construct validity and reliability. Even though researcher insist to have first exploratory analysis followed by confirmatory analysis of the scale.

The consistency of survey data set:

In order to ensure scale reliability, there is measure of internal consistency which means how various items or questions in a scale are closely related or not and it is expressed by "Cronbach's alpha"; ideally this coefficient should be greater than 0.7.

Exploratory Factor analysis of DATA:

During exploratory analysis, one should carry out survey for given construct on pilot respondent of the

order of few hundred or so. Then perform exploration by factor analysis on captured data. The purpose of this whole exercise to firstly ensure convergent validity and reliability of the set of questions secondly by PCA based factor analysis identify most prominent or effective questions.

Why Factor analysis?

When we have data set generated from various responses from respondent; we would like to understand the what type of underline structure exist in the given data set. In our survey data set researcher is looking for common factor which directly map to construct or latent variable and hence ideally there should be one single factor covering maximum variance of the survey data set. In a way it is data summarization to ensure construct validity from acquired data.

In factor Analysis, we are looking for the variables by their correlations, such that variables in groupor factor have high correlations with each other.

When we survey particular construct using 'N' number of questions or items (independent variables)for each respondent and like that we have 'M' number of respondents. Thus our data set is a M x N matrix. Now, we have to establish construct validity through this matrix; particularly we are interestedto check "Explained variance" of these variables data which is indicated by how much a variable's variance is shared with other variables in that factor versus what cannot be shared (Unexplained variance).

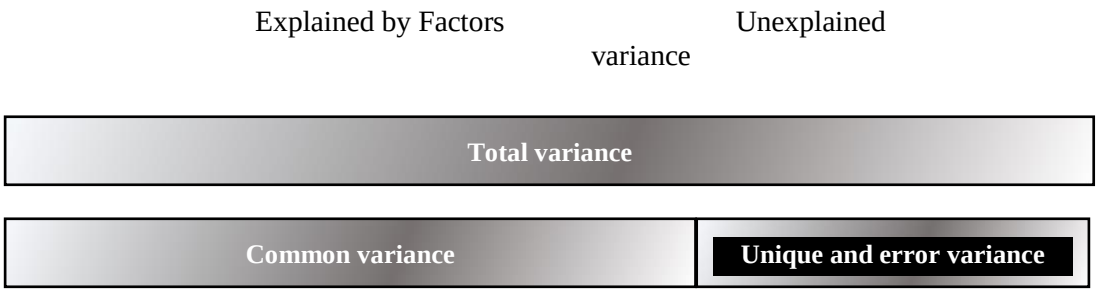


Figure 2.

Common variance: It is the estimate of its shared or common variance among the variables as represented by the derived construct. This component is more commonly called "Communality".

Unique variance: It a specific variance of associated with on a specific variable and it cannot be explained by the correlations to the other variables.

Error variance: It is due to unreliability in the data capturing process, measurement error or randomness in measurements. [10]

Researchers are going to deploy Component analysis or more specifically Principal component analysis(PCA) with the objective is to summarize most of the variance in minimum number of factorfor prediction purposes. PCA even though considers the total variance with small portions of Unique and Error variance; first few components are majorly covers common variance only.

In the process of indirect measurement of construct by set of latent variables which are survey questions; our main intention is reduce number of question but without losing measurement validityand reliability.

Factor Interpretations from result tables:

Factor analysis can be iterative process to get best factors out of dataset employed. The researchers should experiment- evaluate-refine parameters and analysis recursively to get best outcome.

Factor rotations:

Initially un-rotated factor matrix is analyzed in which Factor loading is specified. Factor loadings arethe correlation of each variable and the factor. Loading mean the degree of close relationship between the latent variables and factor; with higher loading means the variable associated as closerepresentative of factor or indirectly the construct. This un-rotated solution may not be optimal one;hence researcher can experiment with rotation method to get improvised results.

The major effect rotation of factors is to redistribute the variance from earlier one to achieve a simpler, theoretically more meaningful factor pattern. There are two types of methods in factor rotation 1. Orthogonal 2. Oblique. In first one number of factors always maintained at 90 degrees apart in terms of axes where as in second one no such limitation employed. In orthogonal method there can be three different approaches deployed 1. QUARTIMAX 2. VARIMAX 3. EQUIMAX. With

this theoretical back ground so far; researchers would like to demonstrate actual measurement scale development using exploratory analysis. We are considering the survey data of 116 final year engineering students of NMIMS university, Mumbai for non-cognitive skill as "**Academic Motivation"** as a construct.

This scale is with 15 questions orginally taken from reference paper as Listed in Annexuture I. Following is study of validation and improvization using pilot data. For analysis IBM SPSS and AMOS is used.

Relability test using Cronbach Alpha:

Reliability Statistics	
Cronbach's Alpha	N of Items
.742	15

As Cronbach Alpha coefficient is greater than 0.7 means there is good internal consistency in the measurement data.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.809
Bartlett's Test of Sphericity	Approx. Chi-Square	755.826
	df	105
	Sig.	.000

Table 1.

Table 1 indicates KMO and Bartlett's test; significance of KMO sample adequacy is check that the data set is suitable for factor analysis or not. The criteria for KMO values between 0.8 and 1 indicate the sampling is very nicely adequate; 0.8 to 0.6 it is moderately adequate while less than 0.6 is not considered to be adequate. Hence in this case dataset is quite adequate for factor analysis. Second part of Table 1 is Bartlett's Test of Sphericity ; this parameter is indicator for all items of construct are correlated with each other and if they are not then data set not suitable for Factor analysis. It basically tests hypothesis as the correlation matrix is an identity matrix i.e. all diagonal elements are one and all off-diagonal terms are zero. If p-values is <0.001 it's good and one can continue with factor analysis.

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.919	32.793	32.793	4.919	32.793	32.793
2	2.817	18.781	51.574	2.817	18.781	51.574
3	1.479	9.860	61.434	1.479	9.860	61.434
4	.944	6.293	67.727			
5	.770	5.135	72.862			
6	.704	4.694	77.557			
7	.607	4.044	81.600			
8	.508	3.384	84.985			
9	.418	2.785	87.770			
10	.396	2.637	90.407			
11	.373	2.484	92.892			
12	.341	2.274	95.165			

13	.283	1.890	97.055			
14	.249	1.661	98.716			
15	.193	1.284	100.000			
Extraction Method: Principal Component Analysis.						

Table 2

Table 2 reflect actual Factor analysis; the Eigenvalue is total variance explained by each factor in a given data set. If any factor which has eigenvalue less than 1 is disregarded. As per the observationof our data set there are three factors notice which cover cumulative percentage variance of total responses as about 61%.

Component Matrix[a]			
	Component		
	1	2	3
AM1	.615	-.280	.320
AM2	.683	.055	-.201
AM3	-.484	.628	.325
AM4	.488	.374	-.489
AM5	-.520	.645	.289
AM6	.409	.622	.231
AM7	.687	-.209	.439
AM8	-.430	.639	.265
AM9	.674	.167	.353
AM10	.591	.400	-.422
AM11	.556	.303	.235
AM12	.588	-.304	.361
AM13	.599	.475	.008
AM14	.727	-.139	-.004
AM15	.404	.574	-.320
Extraction Method: Principal Component Analysis.			
a. 3 components extracted.			

Table 3

Table 3 is the component matrix using PCA (Principal component analysis); it indicates as there are three major components observed and items wise correlations of the factors. Factor analysis with **Varimax** rotation for improvisation of results.

Rotated Component Matrix[a]			
	Component		
	1	2	3
AM1	.677	.011	-.317
AM2	.336	.532	-.337
AM3	-.151	-.051	.842

AM4	-.024	.771	-.148
AM5	-.202	-.042	.853
AM6	.414	.507	.422
AM7	.808	.035	-.235
AM8	-.155	.018	.800
AM9	.714	.310	.020
AM10	.095	.812	-.138
AM11	.539	.389	.117
AM12	.689	-.041	-.305
AM13	.399	.640	.124
AM14	.519	.333	-.410
AM15	.024	.762	.123
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			

Table 4

Table 4 with varimax rotation deployed; we can notice different questions contribute different factors majorly as per colour code. Hence considering first component we will retained AM1, AM7, AM9, AM11, AM12 and AM 14 as items in the scale and re-evaluate again for all above parameters.

Reliability Statistics	
Cronbach's Alpha	N of Items
.811	6

With reduce scale Cronbach Alpha coefficient has improved from 0.742 to 0.811.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.842
Bartlett's Test of Sphericity	Approx. Chi-Square	202.713
	df	15
	Sig.	.000

Table 5

It can be confirmed as KMO and Bartlett's test are satisfactory.

Total Variance Explained		
	Initial Eigenvalues	Extraction Sums of Squared Loadings

Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.118	51.974	51.974	3.118	51.974	51.974
2	.874	14.574	66.547			
3	.651	10.848	77.396			
4	.497	8.292	85.687			
5	.468	7.805	93.493			
6	.390	6.507	100.000			
Extraction Method: Principal Component Analysis.						

Table 6

It is observed from Table 6; that about 52% variance is captured by this revised scale and there is only one unique factor observed.

Component Matrix[a]	
	Component
	1
AM1	.750
AM7	.821
AM9	.749
AM11	.535
AM12	.722
AM14	.716
Extraction Method: Principal Component Analysis.	

Table 7

Further experimentation is perform to check any improvisation in scale by adding AM4, AM10 andAM 15.

Reliability Statistics	
Cronbach's Alpha	N of Items
.802	9

Cronbach Alpha coefficient has not change much.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.787
TBartlett's Test of Sphericity	Approx. Chi-Square	343.908
	df	36
	Sig.	.000

Table 8

It can be confirmed as KMO and Bartlett's test are satisfactory.

Total Variance

Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.548	39.423	39.423	3.548	39.423	39.423
2	1.804	20.042	59.465	1.804	20.042	59.465
3	.848	9.427	68.893			
4	.654	7.265	76.158			
5	.577	6.414	82.572			
6	.510	5.664	88.236			
7	.432	4.795	93.031			
8	.338	3.753	96.784			
9	.289	3.216	100.000			
Extraction Method: Principal Component Analysis.						

Table 9

It is observed form Table 8; that there is more variance covered but not that significant as there isno unique factor observed. Hence there is no point adding three more items in scale.
Refereeing to component matrix in Table 7; as AM11 has low loading factor and hence we can explore as how the results are without AM11.

Reliability Statistics	
Cronbach's Alpha	N of Items
.819	5

Cronbach Alpha coefficient has not change much; rather improve a bit.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.835
Bartlett's Test of Sphericity	Approx. Chi-Square	178.384
	df	10
	Sig.	.000

Table 10

It can be confirmed as KMO and Bartlett's test are satisfactory.

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.906	58.113	58.113	2.906	58.113	58.113
2	.685	13.697	71.810			

3	.520	10.402	82.212			
4	.496	9.926	92.137			
5	.393	7.863	100.000			
Extraction Method: Principal Component Analysis.						

Table 11

It is observed from Table 10; that about 58% variance is captured by this revised scale and there is only one unique factor observed. Hence by experimenting with dataset we can conclude as originallyscale of 15 items can be reduce down to 5 only without losing much information captured for the construct.

Conclusion and Remarks:

As per the various research and literature reviews carried out internationally; there is urgent and obvious need of addressing Non-cognitive skill in education system. Education process is longitudinal one and have ever lasting impact on student mental build up in terms of cognitive as wellas non-cognitive aspects for holistic development as a professional educated person. Thus educationpolicy makes should incorporate majors to measure non-cognitive skills along with other evaluation processes and develop students if they are lagging on these skills. After understanding need of the measurement for non-cognitive skills; the next task is developing an instrument which should validated for its reliability and validity. This paper experimentally demonstrated that we need to develop survey instrument to capture non-cognitive skills of students which should be most effectiveand sensible. Future research can be for identification of most vital Non-cognitive skills from contextof Educational performance, Professional performance and Social performance. It required to develop survey instrument and gather huge data from various institution on different aspects of non-cognitive skill and perform comparative studies.

Annexure I:

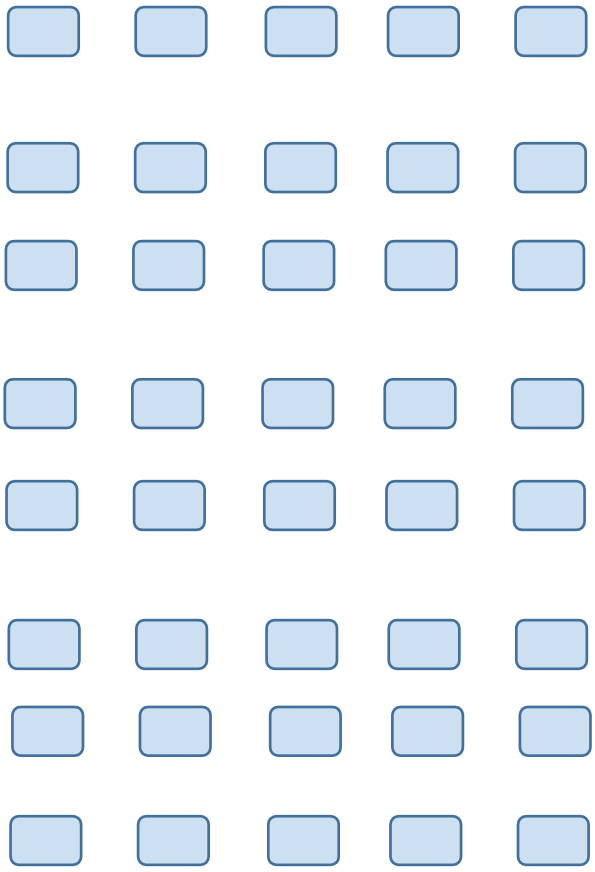
Construct**: Academic Motivation**

WHY DO YOU GO TO Engineering College?

	Very much like me (1)	Mostly like me (2)	Somewhat like me(3)	Not much like me (4)	Not at all like me (5)
1. Because I experience pleasure and satisfaction while learning new things.					
2. Because I think that a college education will help mebetter prepare for the career I have chosen.					
3. Because with only a high-school degree I would notfind a high-paying job later on.					
4. Honestly, I don't know; I really feel that I am wastingmy time in school.					
5. For the pleasure I experience while surpassingmyself in my studies.					
6. To prove to myself that I am capable of completing mycollege degree.					
7. Because of the fact that when I succeed					

in collegeI feel important.

8. For the pleasure that I experience in broadening my knowledge about subjects which appeal to me.
9. I can't see why I go to college and frankly,I couldn't care less.
10. For the "high" feeling that I experience while reading about various interesting subjects.
11. Because my studies allow me to continue to learn aboutmany things that interest me.
12. For the satisfaction I feel when I am in the process of accomplishing difficult academic activities.
13. Because college allows me to experience a personal satisfaction in my quest for excellencein my studies.
14. Because I want to have "the good life" later on.
15. To show myself that I am an intelligent person.



THE ACADEMIC MOTIVATION SCALE (AMS): FACTORIAL STRUCTURE, INVARIANCE, AND VALIDITY IN THE ITALIAN CONTEXT; FABIO ALIVERNINI ITALIAN NATIONAL INSTITUTE FOR THE EDUCATIONAL EVALUATION OF INSTRUCTION AND TRAINING FABIO LUCIDI UNIVERSITY OF ROMA "LA SAPIENZA"

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