How to Build Innovative Competency-Based Education in Adolescents' Communities? A Case Study of Montessori Cluj

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Please cite this paper as:
Cadis, A.I. and Busu, M.,2022. How to Build Innovative Competency-Based Education in Adolescents' Communities? A Case Study of Montessori Cluj. In: R. Pamfilie, V. Dinu, C. Vasiliu, D. Pleșea, L. Tăchiciu eds. 2022. *8th BASIQ International Conference on New Trends in Sustainable Business and Consumption.* Graz, Austria, 25-27 May 2022. Bucharest: ASE, pp.306-312.
DOI: 10.24818/BASIQ/2022/08/040

Abstract

Innovative competency-based education in adolescents' communities is one of the most challenging thins of the new millennium. Researchers from all over the world are trying to find models of competency-based education for the young and adolescent students. In this paper, starting with the last available data of the OECD Program for International Student Assessment (PISA), the authors are analyzing the results using a linear regression modeling. Their findings reveal that there is an inverse relationship between the science performance and the total study time in after school hours. One solution that the authors give is the alternative education in general and boarding school within the alternative Montessori educational system. The novelty of the paper is the econometric analysis of the data obtained by students in PISA tests and the use of these results to achieve an innovative education based on skills in adolescent communities. The results of this work could be used both by parents to choose a suitable school for their children and for the governors, to create a national educational ecosystem based on the development of adolescents' skills.

Keywords

alternative education; innovation; competence; Montessori; Erdkinder; adolescence; boarding school; campus.

DOI: 10.24818/BASIQ/2022/08/040

Introduction

On the path of fulfilling its mission, Montessori sets out to cultivate respect, compassion, and gratitude for mankind, strong power of adaptation to unknown, like the capability to innovate including in the field of digitalization, artificial intelligence, and automatization. It focuses on independence, responsibility for self and others, awareness of caring for the environment and a deep sense of love for work.

There are several aspects in setting up the environment for the adolescents like the ownership which belongs to the adolescents and the professors which will be involved as experts, generalists, co-workers in all community work tasks. The primary task of the student is not academic success; it is self-construction and adaptation to the current technological trends. The major focus is driven by the work of building the environment on the developmental task and the psychological needs of the adolescents while the challenge is to find, involve, train adults with the right competence profile - from generalists to specialists who create the right open program, with long periods of uninterrupted work time, no broken-up schedule, large periods of open and chosen work, while students have the time to engage in deep, meaningful work.

To support the achievement of social and economic independence of the adolescents we need to provide the framework for work for everybody, prepare the framework for finding "projects", setting goals, and work independently to achieve them - students and adults involved. The feeling of valorization is needed for everybody in the community - students as well as adults. They need to experience the value of their work. Living in community, they all will have the chance to give valorization as well as to receive it. The more diverse the opportunities are for contributions to the community, the more opportunities there are for valorization.

"Work makes study better". The challenge and responsibility are to provide the right work for everybody in the community. The developmental tasks arise from the characteristics of adolescents which depend on gender and individual maturity level.

The developmental task of the adolescent in the view of Maria Montessori is also related to the economic and social independence.

"*The essential reform is this: to put the adolescent on the road to achieving economic independence". The emphasis ultimately seems to fall on valorization through work that is meaningful: "For [economic independence] would result in a 'valorization' of his personality, in making him feel himself capable of succeeding in life by his own efforts, and on his own merits, and at the same time it would put him in direct contact with the supreme reality of social life"* (Montessori, 1996, p.64).

Students should be involved in a real cycle of production and exchange, and they should receive some sort of tangible benefit from the work. Montessori links this process to economic independence and the need for "experience in the elements of social life". The environment that Montessori described as best suited for this the developmental task is an operating farm where students live, work, and study in a microcosm of society, while engaging in the farm community's related production and exchange activities.

The farm as environment provides a multi-faceted experience of meeting fundamental human needs in very concrete ways: providing one's food, maintaining the buildings where one lives and works, participating in economic endeavors, interacting with the natural world, adapting to, and building upon the natural world in supra-nature. The Farm should be complemented with the IT and AI Innovation Lab.

Adolescents gain experience in selling things and commerce, express themselves, get involved in production, selling and exchange. The guesthouse - which includes the opportunity to organize meals, think about healthy nutrition and plan accordingly, social life with unknown people, controlling and finance, maintenance, decorating, organizing for comfort and order etc. The work on land - the adolescent is learning and understanding the methods of doing automatized agriculture as part of his understanding of nature and supra nature. In Figure 1 below we could see the degree of work independence and adult dependence depending on the maturity level of the adolescent.

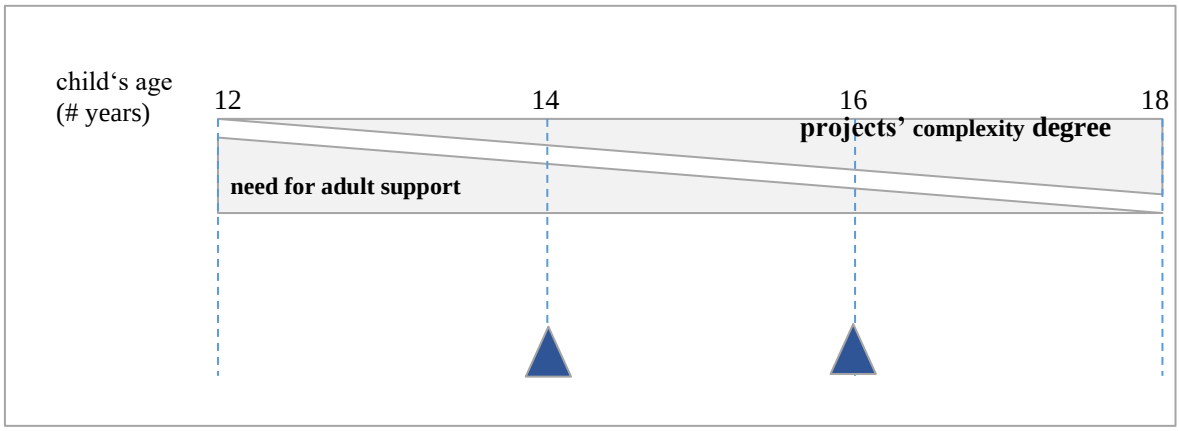

Figure no. 1. Degree of work independence and adult dependence depending on the maturity level of the adolescent

Source: own analysis

1. Review of scientific literature

Adolescents' community has been analyzed by many researchers. In his paper, Kahn (2001) analyzed the behavior of adolescent students at The Hershey Montessori Farm School. When compared with students from other traditional schools, it resulted that the students from Hershey Farm School have higher quality of experience while doing academic activities. Their results suggest that the students from Montessori have perceived their classmates as friends, have a better understanding of the environment and spent more time on doing collaborative projects rather than being passive in the class while listening to the lecturers given by their teachers.

Ayer and Stone (2006) are analyzing the boarding experience (separation from families) of the Montessori adolescents. They describe the boarding environment as an opportunity for the young children to take initiative and assume responsibility, even if that could lead to a failure. The authors conclude that the

boarding students are less fashionable than the day students. They are also engaged, bright-eyed and independent.

The social evolution of the Montessori community was described by Kahn (2006). After ten years of intensive research, the author concludes that the Montessori environment is following the expectations of Montessori theory and practice. Moreover, he argues that the teachers, adolescents, and their parents together make a "little community" which is a base for learning and future adaptation of the society's demands.

Castiglione (2016) made a presentation of the Near North Montessori School of Chicago and its approach to technology. Her research starts from the adolescent needs for social acceptance, independence, and social justice. She creates a template with seven characteristics of the adolescents' behavior: social, independent, adaptability, real, safety, order, beauty, structure, and the role of the guide. The author concludes that, to help the adolescents to grow, the teachers have to know, challenge, create space for them to invent, and understand the new technology.

In a study focused on the seventh-grade students of the Montessori program, Casquejo Johnston (2016) analyzed the self-determination feelings of the students throughout the academic year to capture the change in self-determination. The research was designed to give voice to students, provide a perspective of the students and add a disclosure on middle-school reform. The study provides ways in which, the Montessori adolescent program could help its students and suggests ways for other secondary schools to provide support to their students.

McNamara (2016) is making a description on how the Montessori upper elementary adolescent students integrates science, technology, mathematics, and the environment. Starting with what he had learned from his professors, the author shares the lessons to his own students. Languages, history science and math are so integrated in the curriculum that the students did not even think that they were doing math or science.

Casquejo Johnston (2019) considers that, while most Montessori students are three-to six-years old children, many researchers do not know that Montessori wrote and spoke about middle level education before 1952. In her paper, the author describes the learning environment for students between 12 and 16 years old. This learning environment includes the four essential attributes as well as a few innovations related to them. According to the Montessori's writings, personalized learning creates a learning environment where the students are encouraged to innovate.

Ewert-Krocker (2013) argues that, until a child is twelve years old, nature ought to constitute his primary interest. After he reaches twelve, the feeling of society must be developed in each child, with the goal to contribute to a better understanding of the people and then, as a result, to more love.

In another research, Hoffman (2009) discusses the major issues faced by Montessori schools and teachers and the resources needed to transform them, such as translating adolescent and child development literature into a friendly user format for delivery links and courses to the accreditation process. The author highlights theories and principles derived from investigations and ongoing research presented to the roundtable meetings.

Thakur and Patnaik (2017) realized a study to analyze the effect of adolescent education on their reproductive health. The analysis was based on two groups, one treatment and the other one control group, each group consisted of 102 students. There was a pre-test followed by a post-test administrated to both groups and mean, standard deviation and t-test were calculated. It came out that the difference between the two groups was statistically significant.

Colby (2019) conducted an analysis based on a sample of 1380 students from secondary schools in EU countries in terms of competence-based education. The results of the study show that there are still significant differences in the results of high school students between developed and developing countries. Similar results were obtained by other researchers (Lurrie and Garett, 2017; Gruppen at el., 2016).

2. Case study Montessori Cluj

Montessori Cluj Campus is a state-of-the-art research and development center aimed at driving global transformation in the field of scientific education for 12- to 18-year-olds through bridging Montessori established methods with technology. In Figure 2 is described the state-of-the-art technology.

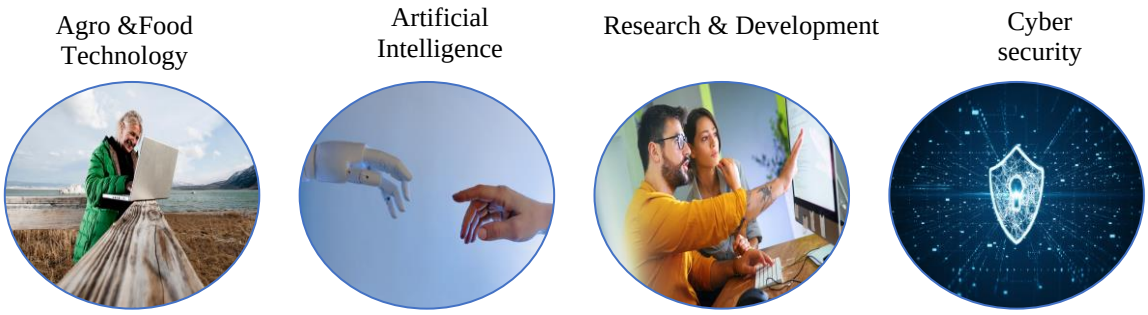

Figure no. 2. State of the Art Technology
Source: own analysis

We believe that human life will be improved by grate minds that will be able to design, create and master systems of extraordinary complexity. We aim to channel cutting edge technology in all aspects of the operations and by bridging nature, nurture, and state of the art technology together, to have truly a valuable impact into education, globally. The concept concentrates technology on 4 major pillars.

Key concept of our work is to harness all the power of the data and to use it in terms of reimagining the most valuable experiences we can offer to youth all over the world. Unlimited customizable learning ecosystem providing deep learning and modelling is based on Montessori Scientific observation and Artificial Intelligence.

The Montessori Campus is a smart campus equipped with the latest technology and facilities all in green buildings, especially featuring latest food technology and safety, bio sciences & bio engineering lab, a museum of machines and a robotics and artificial intelligence lab. It is designed to offer a prepared environment for the 12 to 18 adolescents so that they can grow into their natural duty: to become the best version of adults they can be.

3. Research methodology

In order to check the efficiency of the traditional learning system, we alalyzed an ordinal least square (OLS) simple linear regression model with one dependent variable and one indepedent variable.

$$y = \beta_0 + \beta_1 x + \varepsilon \quad (1)$$

where,

y = dependent variable
x = independent variable
β_0, β_1 = parameter coefficients.
ε = residual coefficient

The regression equation is statistically significant if the p_value is below the 0.05 threshold. Moreover, the model does not have autocorrelation errors oif the variance inflation factor is between 1 and 5, while the Durbin-Watson test is close to 2. We have also calculated the coefficient of determination (R^2), which shows us what percentage of variation of the dependent variable is explained by the variation of the independent variable.

$$R^2 = 1 - \frac{SSres}{SStot} \quad (2)$$

SStot is the total sum of squares and SSres is the total sum of the residuals. They are calculated using the formulas:

$$SStot = \sum_{i=1}^{n} (yi - \varepsilon i)^2 \quad (3)$$
$$SSres = \sum_{i=1}^{n} (yi - \bar{y})^2 \quad (4)$$

where,

yi = predicted values
$\bar{y}$ = mean of the predicted values
εi = residuals

For the above regression model, we will test Durbin-Watson statistic to test the presence of autocorrelation of the errors. The statistic is:

$$d = \frac{\sum_{i=2}^{I}(ei - ei-1)^2}{\sum_{i=1}^{I} ei^2} \quad (5)$$

Moreover, we will test the multicollnearity with the variance inflation factor (VIF). The value of the VIF statistic could be calculated by the formula:

$$VIF = 1 - \frac{1}{1-R^2} \quad (6)$$

4. Results and discussion

The first step in our analysis was to plot the science Pisa score versus total time of study in the selected countries. The results could be seen in Figure 3.

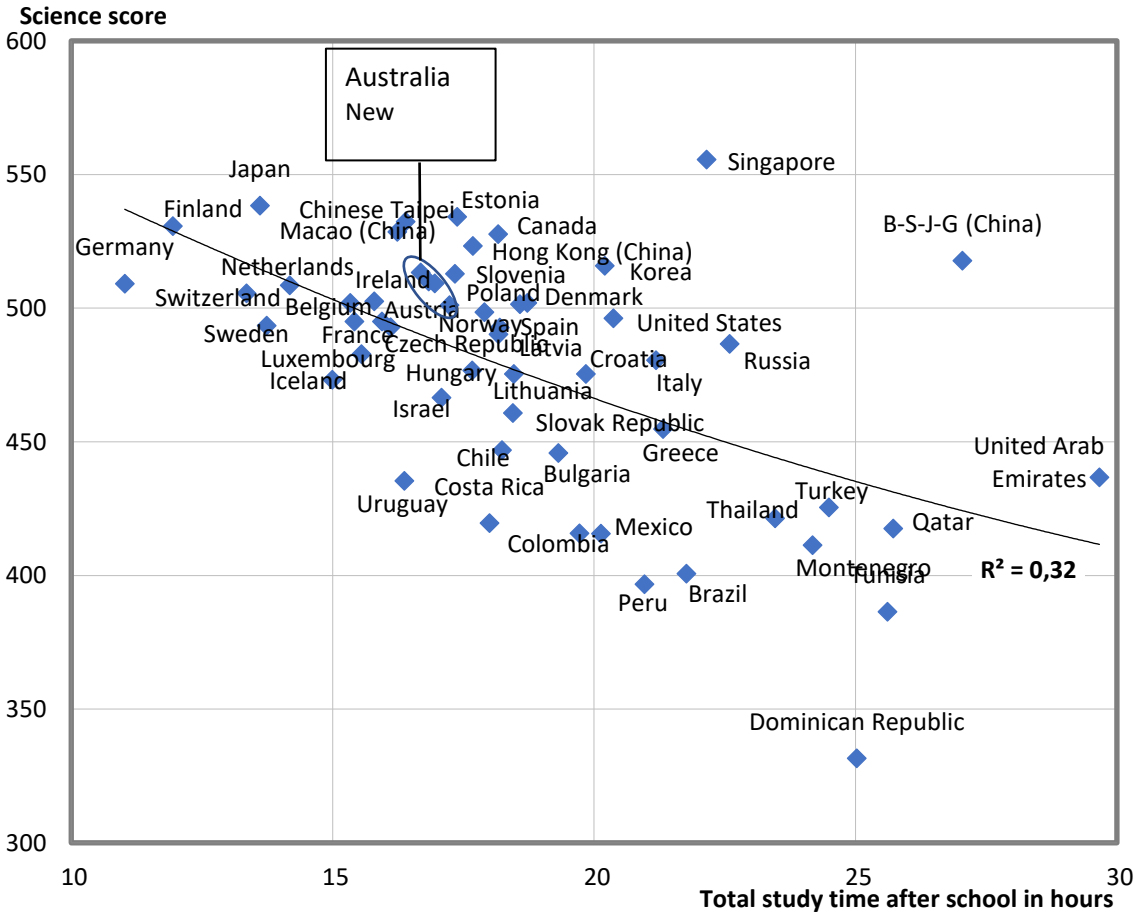

Figure no. 3. Science score vs total time after school in hours
Source: PISA 2018 score results

From the graph above, we could see that there is an inverse correlation between the total study time in after school hours and the science score in the selected countries. In other words, the average science score is lower in countries and economies where students spend more time learning after school.

We could also see that the countries with the best ratio of science score to total time after shool hours are Japan, Estonia, Canada and Hong Kong, while the countries with the lowest ratio of science score to total after school hours are Dominican Republic, Tunisia, Montenegro, Peru and Brasil.

We have also perfeormed a quantitative analysis, where have used the OLS methodology to obtain a simple linear regression equation with the dependent variable the science score and the independent variable the total study time in after school hours. The results could be seen in the tables 1-3.

Table no. 1. ANOVA table

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36752.849	1	36752.849	24.775	.000[b]
	Residual	80108.133	54	1483.484		
	Total	116860.982	55			

Nots: a. Dependent Variable: Mean_score_science; b. Predictors: (Constant). Total_study_time

Table no. 2. Model summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.561[a]	.315	.302	38.516	2.140

Notes: a. Predictors: (Constant). Total_study_time; b. Dependent Variable: Mean_score_science

Table no. 3. Model coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	604.438	26.119		23.142	.000		
	Total_study_time	-6.812	1.369	-.561	-4.977	.000	1.000	1.000

Note: a. Dependent Variable: Mean_score_science

From Table 1 we could conclude that the model is statistically significant as the p_value (Sig. = 0.000) is below the 0.05 threshold. From the second table we could see that the correlation coefficient is 0.561. That means the mean score results and total study time or moderately correlated. Moreover, the Durbin-Watson statistic (DW=2.14) is close to 2, which means that the residuals are not autocorrelated. Also, VIF is greater than 1, which makes us conclude that there are not multicollinearity issues for the model.

From the values of the coefficients from Table 3, results the linear regression model.

$$Mean\ score\ in\ science = 604.44 - 6.81(Total\ study\ time) + \varepsilon \quad (6)$$

From this regression equation we could conclude that for each additional study time hour, the mean score in science would decrease by 6.81 on average.

Conclusions

The regression analysis revealed that there is an inverse relationship between mean score in science and total study time in after school hours in the selected countries. In other words, the more time the students spend in after school, the less grade they get. This is an argument for Montessori boarding program, which integrates the study time in all their activities.

The quantitative model was well defined and statistically significant. The linear model assumptions were tested and validated by the regression model. The results of the econometric analysis are in line with other recent studies on innovative competency-based education in adolescents' communities (Sullivan and Downey, 2015; Gruppen, et al., 2016; Levine and Patrick, 2019).

The profound psychic development emerging from the body-mind-hand connection is lived within a community context at the Farm School combined with the IT and AI innovation Lab. The community life

is about all the things that the adolescents and the adults that live there do together. Also, it should lead to a complete economic independence and interdependence.

A limitation of the study is related to the data availability. Future research should focus on recent data add more variables to the model. This study could be useful for government, public and private education institutions as well as for the local and central communities.

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