

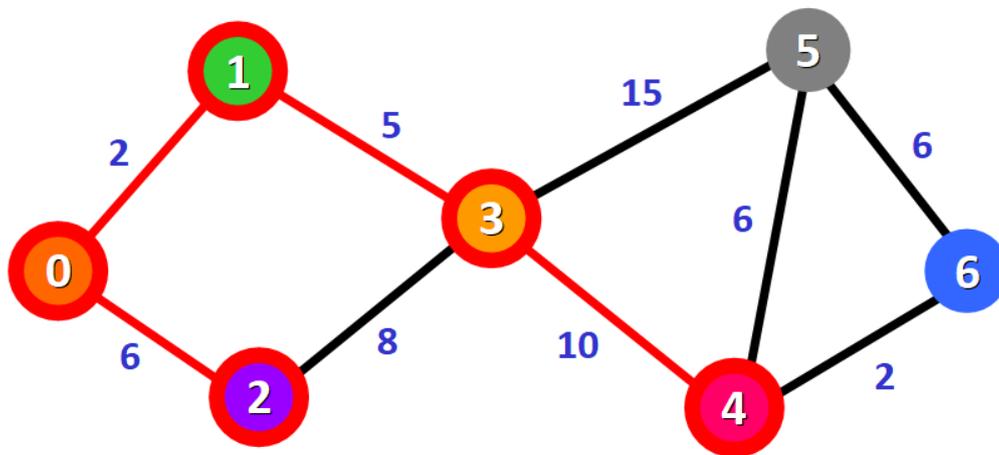
Algorithmic Thinking for Migrants Teachers Education

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Trainers Support



Handbook: “Algorithmic Thinking for adult migrants’ trainers support”



Our team



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“The significant problems we face cannot be solved at the same level of thinking we were at when we created them.”

Albert Einstein



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Part I NATIONAL & EUROPEAN POLICIES

Chapter 1 MIGRATION POLICIES

1.1 EUROPEAN POLICY FOR SOCIAL INTEGRATION

1.1.1 Introduction to European Policy



One of the issues the European Union has long debated is the value of diversity in the sense of protection of minorities and intercultural dialogue.

In the Council of Europe, interest in cultural diversity began in the 1970s as a result of the need to address the profound changes that characterised the dynamics of migration in Europe. Moreover, in the 1980s, other states, including Italy, would go from being countries of emigration to countries of immigration, while facing the aftermath of an economic crisis that also marked the political way in which identity claims were managed, as well as the way in which identities themselves were produced. Thus, at this early stage of reflection on the issue of diversity, the point of reference oscillates between a focus on the cultural particularism of migrants, which is the specific object of measures, especially in the educational field, and an emphasis on the need for adherence to shared universal values. Cultural diversity is seen as a permanent phenomenon, linked to clearly identifiable

national identities, and as a positive fact as long as it provides a basis for dialogue and understanding between peoples and not a reason for division. Over the years, the idea has taken hold that it is not only a phenomenon linked to non-European migrations but that it is constitutive of European identity. In fact, the Council documents emphasise that it «is convinced that unity in diversity is what produces the richness of the common European cultural heritage» (*COUNCIL OF EUROPE COMMITTEE OF MINISTERS RESOLUTION (85) 6 ON EUROPEAN CULTURAL IDENTITY (Adopted by the Committee of Ministers, n.d.)*).

As Marco Martiniello, sociologist and director of CEDEM (Center for Ethnic and Migration Studies) at the University of Liège, stated in his scientific article (Martiniello, 2006), that EU entered a process of “diversification of its diversity”, an expression introduced by David Hollinger to describe the dynamics of cultures and identities in the US context.

1.1.2 Cultural and social bases of European Policy for Social Integration

According to the sociologist, it seems that this process calls for a specific European debate about European forms of diversity management. As everyone knows, the European Union displays a wide variety of ethnocultural and national affiliations and identities due to the fact that it is composed of 25 states, each of which is linked to a specific history of the nation and to specific national identities. As a consequence, it is crucial to try to invent new policy tools in order to combine ethnic and cultural diversity, social and political cohesion and equal opportunities in a very diverse Europe. One could in that context advocate the emergence of a new EU model of multicultural citizenship.



The recognition of these rights guarantees the possibility of expressing one's diversity, not only of one's philosophical, political, religious or spiritual opinions but also of the way one expresses them and the way one lives while remaining within the framework of a society based on respect for the individual, tolerance and solidarity. Human rights are thus, on the one hand, an expression of a particular culture, the European one, and on the other hand, they aspire to cover a universal ethical value that allows both to protect diversity and to ensure communication between them, in particular through intercultural dialogue. According to Martiniello's document, "Towards a coherent approach to immigrant integration policy(ies) in the European Union" there is a right/duty of European citizens towards their own and others' cultural identity, as a heritage to be protected, and intercultural dialogue is the way to achieve this. This implies attention to one's own and others' diversity, further enriched by the contribution of the cultural heritages of the rest of the world.

Following the increased arrival of third-country nationals in Europe during the last years, integration has become a crucial issue. For this reason, the EU has periodically set priorities and goals to drive EU policies, legislative proposals and funding opportunities since the 1999 Treaty of Amsterdam (*EUR-Lex - 11997D/TXT - EN*, n.d.). It consists of five stepping stones which provide incentives and support for the action of Member States with a view to promoting the integration of third-country nationals.

1.1.3 1992 to 2004: Genesis of a common policy

With the Treaty of Amsterdam, EU policies could affect, for the first time, the integration of migrants from non-EU countries. Adopted in 1997, the treaty entered into force in 1999. From then on, the EU could take appropriate action to combat discrimination, including that based on racial or ethnic origin and religion or belief. The EU was also mandated to develop a common immigration policy.

This policy was guided until 2004 by the so-called Tampere Programme, wherein Member States agreed that the aim of such policy should be to grant third-country nationals rights and obligations comparable to those of EU citizens. In November 2004, The Common Basic Principles (CBP) were aimed at designing a common framework for a European approach to immigrant integration. The paper suggested a framework to serve as a reference for the implementation and evaluation of current and future integration policies. The principles are:

1. Integration is a dynamic, two-way process of mutual accommodation by all immigrants and residents of Member States.
2. Integration implies respect for the basic values of the European Union.
3. Employment is a key part of the integration process and is central to the participation of immigrants, to the contributions immigrants make to the host society, and to making such contributions visible.
4. Basic knowledge of the host society's language, history, and institutions is indispensable to integration; enabling immigrants to acquire this basic knowledge is essential to successful integration.

5. Efforts in education are critical to preparing immigrants, and particularly their descendants, to be more successful and more active participants in society.
6. Access for immigrants to institutions, as well as to public and private goods and services, on a basis equal to national citizens and in a non-discriminatory way is a critical foundation for better integration.
7. Frequent interaction between immigrants and Member State citizens is a fundamental mechanism for integration. Shared forums, inter-cultural dialogue, education about immigrants and immigrant cultures, and stimulating living conditions in urban environments enhance the interactions between immigrants and Member State citizens.
8. The practice of diverse cultures and religions is guaranteed under the Charter of Fundamental Rights and must be safeguarded unless practices conflict with other inviolable European rights or with national law.
9. The participation of immigrants in the democratic process and in the formulation of integration policies and measures, especially at the local level, supports their integration.
10. Mainstreaming integration policies and measures in all relevant policy portfolios and levels of government and public services is an important consideration in public-policy formation and implementation.
11. Developing clear goals, indicators and evaluation mechanisms are necessary to adjust policy, evaluate progress on integration and make the exchange of information more effective.

2005 - 2010: Knowledge exchange

The Common Agenda for Integration, presented by the Commission in 2005 and in effect until 2010, was the strategy document providing the framework for the implementation of the EU integration policy. It contained a series of supportive EU mechanisms and instruments to promote integration and facilitate exchange between integration actors.

2011 - 2015: Funding for integration

Prior to the 2016 action plan, the European Agenda for the Integration of Third-Country Nationals, adopted in July 2011, guided migrant integration issues. The Agenda, which covered the period 2011-2015, focused on increasing the economic, social, cultural and political participation of migrants and on fighting discrimination, with an emphasis on local actions. It also explored pre-arrival measures and the role of countries of origin in integration. The multiplicity of funding opportunities made available is another major legacy of this period.

2016 - 2020: The holistic approach

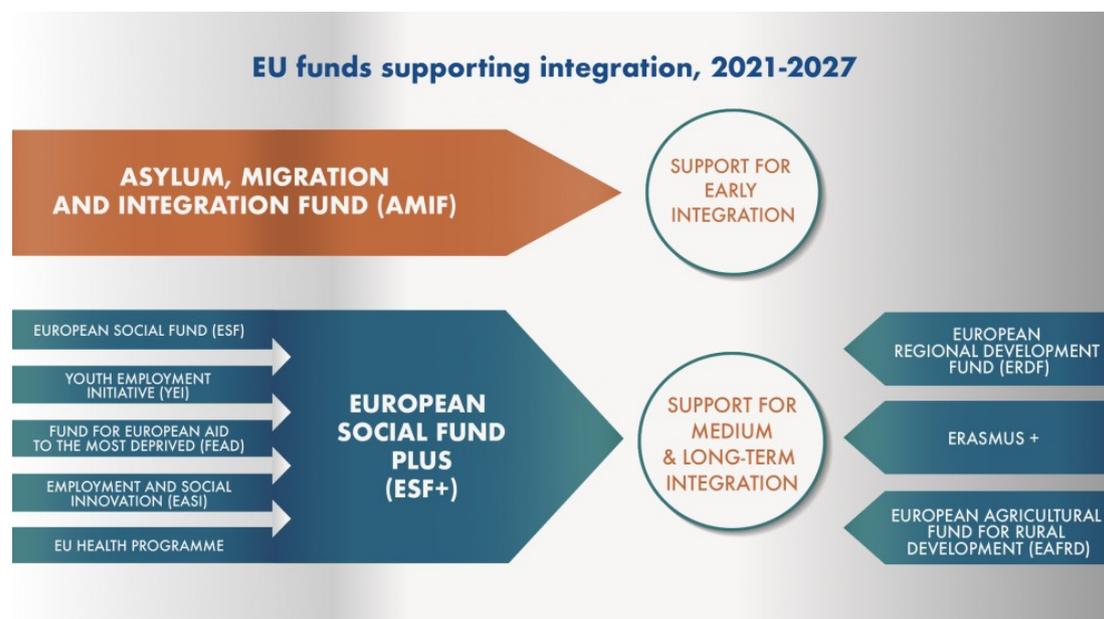
The June 2016 action plan on integration was a goal-setting document published by the European Commission. It provides a comprehensive framework to support Member States' efforts in developing and strengthening their integration policies and describes concrete measures the Commission will implement in this regard.

2021 – 2027: new action plan on integration and inclusion

Guided by the overarching principle ‘inclusion for all’, the action plan envisions:

1. **Inclusive education and training** from early childhood to higher education, focusing on easier recognition of qualifications and continued language learning, with support from EU funds.
2. **Improving employment opportunities and skills recognition** to fully value the contribution of migrant communities, and women in particular, and ensure that they are supported to reach their full potential. The EC will work with relevant stakeholders to promote labour market integration, support entrepreneurship and make it easier for employers to recognise and assess skills.
3. **Better access to health** services, including mental healthcare, for people with a migrant background. In addition to dedicated EU funding, the Action Plan seeks to ensure people are informed about their rights and recognises the specific challenges faced by women, in particular during and after pregnancy. The Action Plan also supports the exchange of good practices and calls for addressing the inequalities in access to services which the COVID-19 pandemic shed additional light on.
4. **Access to adequate and affordable housing** funded through the European Regional Development Fund (ERDF), European Social Fund Plus (ESF +), Asylum and Migration Fund (AMF) and Invest EU, as well as an exchange of experience at local and regional level on fighting discrimination on the housing market and segregation.

1.1.4 Asylum, Migration and Integration Fund (2021-2027)



The Fund, which is set up for the period 2021-2027 (Figure 1), aims to improve procedures for migration management and to enhance solidarity and responsibility sharing between the Member States. The integration fund is going to contribute to the achievement of four objectives:

- to strengthen and develop all aspects of the common European asylum system, including its external dimension.
- to support legal migration to the Member States, including by contributing to the integration of third-country nationals.
- to contribute to countering irregular migration and ensuring the effectiveness of return and readmission in third countries.
- to enhance solidarity and responsibility sharing between the Member States, in particular towards those most affected by migration and asylum challenges.

Also, there are some actions funded through AMIF that include some initiatives, such as:

- providing **support and services** consistent with the status and the needs of the person concerned, in particular vulnerable groups.
- supporting the development and implementation of policies promoting legal migration, such as the development of mobility schemes to the EU and raising awareness of the appropriate legal channels for immigration.
- cooperating with third countries on asylum, legal migration and countering irregular migration and on effective return and readmission for the purpose of managing migration.

Countries may be associated with AMIF, as well as third country nationals unless they have signed an agreement with EU “on the criteria and mechanisms for establishing the EU country who will be responsible for examining an asylum request lodged in an EU country or lodged in that third country”. Third country national have to:

- enable cooperation with the EU country and the EU institutions, bodies, offices and agencies in the area of asylum, migration and return in the spirit of the principle of solidarity and fair sharing of responsibility;



- lay down the conditions of participation in the Fund, including the calculation of financial contributions to the Fund, and its administrative costs;
- not confer on the third country any decision-making power in respect of the Fund;
- guarantee the rights of the EU to ensure sound financial management and to protect its financial interests.

Currently, there are no countries associated or are negotiating their association to AMIF.

1.2 POLICY FOR SOCIAL INTEGRATION (GREECE)

1.2.1 The National Strategy

Social integration is a process that entails mutual accommodation by third-country nationals (migrants, applicants, or beneficiaries of international protection) and Greek residents. Successful social integration leads to peaceful co-existence, respect for diversity and social cohesion.



The current National Strategy for Social Integration was issued in July 2019, following revisions and developments of the National Social Integration Strategy of 2013.

The National Strategy of 2019 contends-based on specifications from the European Council and the European Union, that a successful social integration policy requires the active participation of the State, Institutions, and civil society.

In this context, local communities in Greece are very important for the effective implementation of social integration policies. Local Greek government administrations serve as key vehicles of social integration by involving and engaging local communities.

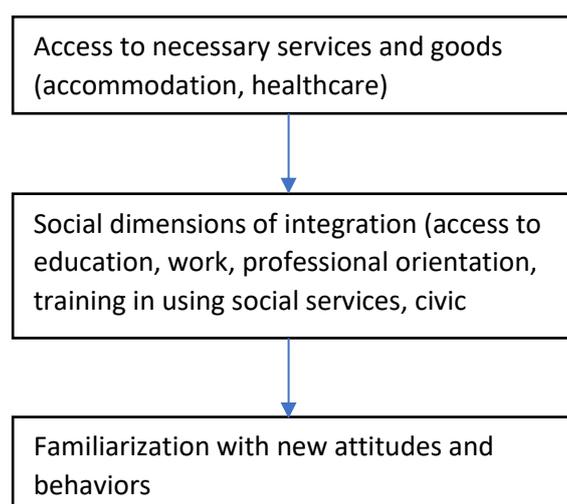
Further, the successful implementation of social integration policies also requires the effective collaboration of local government administrations with the central government administration. It also depends on the active involvement of civil society entities-such as associations or unions for migrants

and refugees and non-governmental organizations, in social integration initiatives (*Greek Policy for Social Integration, 2022*).

1.2.2 The Greek model for social integration

According to the National Integration Strategy of 2019, the main objectives of the Greek model for social integration are (*Greek Policy for Social Integration, 2022*):

- Create and maintain an open society that respects diversity.
- Protect the rights, and outline the obligations of third-country nationals in a non-discriminatory manner that ensures social equality.
- Foster interaction, collaboration, dialogue and constructive criticism between culturally or ethnically diverse communities, promulgating democracy and equality.
- Promote diversity, tolerance and social cohesion.
- Motivate all individuals to protect the common good and encourage the contribution of all individuals to the development of the country.



1.2.3 Strategic and tactical goals of the National Strategy

The current National Strategy for social integration is an evolved strategy that caters to a new international, European and local, socio-economic landscape. The basic tenets of the current strategy are:

- Enable the integration of beneficiaries of international protection and applicants of international protection who temporarily reside in the country, and/or will remain in the country-if they are granted international protection.
- Assist migrants who struggle to maintain their lawful residence status due to the economic crisis.
- Involve more the local government administrations and enhance their role in the formation of social integration policies.
- Raise public awareness with regards to the importance of social integration and inclusion.
- Coordinate and align the activities of all governmental and state bodies towards the implementation of a common national strategy.
- Collaborate and align with international and private state bodies as well as civil society.
- Modernize and digitize the administration processes for resident permits and international protection status.
- Promptly and thoroughly inform migrants with regards to new national developments in migration policy, activities and programs, as well as their rights and obligations in the context of social integration.

1.2.4 Action pillars and policy measures of the National Strategy

The action pillars of the national strategy and their corresponding policy actions and measures are described below:

- Collaboration with the local government administration to promote integration on a local level, which involves actions and measures such as: enhancing the collaboration between the central administration and the local government administration, enabling the participation of local administration bodies in integration initiatives, improving reception services offered to applicants of international protection, improving local reception and integration services, offering accommodation services to beneficiaries and applicants of international protection and enhancing the operation of Migrant Integration Centers (M.I.C.).
- Access to necessary goods and services, which involves actions and measures such as: informing third-country nationals about their access to goods and services, upgrading the operation of immigration services offered by the Ministry of Migration and Asylum, upgrading

public services and local administration services that cater to third-country nationals and enabling third-country nationals' access to the healthcare system.

- Promote inclusive education, which involves actions such as: supporting the integration of children in the educational system and encouraging the participation of adults in continuing education courses.
- Promote labor market integration, which involves actions and measures such as: identifying and recognizing the skills and qualifications of third-country nationals, enabling their access to the job market, and promoting entrepreneurship.
- Enhance Intercultural Mediation, which involves actions and measures such as: developing and expanding the profession of intercultural mediation and encouraging intercultural interaction and dialogue.
- Encourage civic participation, which involves actions such as: enabling third-country nationals' civic and community participation via involvement in community athletic activities and volunteerism.
- Combat racism and xenophobia, which involves identifying and monitoring phenomena of racism and xenophobia and raising awareness with regards to such phenomena.
- Implement targeted integration policies for vulnerable groups such as: promoting the integration of women, the integration of individuals with special needs and the integration of the elderly.
- Implement targeted policies for second-generation citizens to enhance their integration in Greek society.

1.2.5 The basic tenets of the National Strategy

The role of the Ministry of Migration and Asylum

The successful implementation of social integration strategies for third-country nationals (beneficiaries or applicants of international protection, unaccompanied minors, and migrants), requires the collaboration between the Ministry of Migration and Asylum with other Ministries, local government administrations as well as entities of civil society (*Greek Policy for Social Integration, 2022*).

The role of the Local Government Administrations

As stated in the Common Principles of the European Union for social integration: "Integration must take place foremost at the local level of communities, be a part of everyday life and engage everyone. In order for integration to be successful, it is important to identify opportunities for third-country nationals'

active participation in Greek society. Thus, the active involvement of communities in integration initiatives is key.”

Community Centers of municipalities and Migrant Integration Centers (*Migrant Integration Centers*, 2020) cater to the individual needs of third-country nationals by offering «One Stop-Shop» services in collaboration with the Directorate of Social Services of each local administration. M.I.C. as well as Community Centers in each municipality connect third-country nationals with all social service programs offered in each municipality area.

More specifically, M.I.C. and Community Centers offer information and guidance on programs such as the following:

- a) Information and support to apply for the Social Solidarity Income and the Fund for European Aid to the Most Deprived (FEAD)
- b) Information and support to apply for social services such as the “Home Aid,” “Daily Care for the Elderly,” “Daily Care for Individuals with Special Needs,” the educational seminars of the General Secretariat of Lifelong Learning, as well as other professional training courses and educational seminars.

Further, the Migrant and Refugee Integration Councils (*Civic Participation*, 2020) which serve as counseling bodies in municipalities on migrant and refugee issues (Law 4555/2018, “Klithenis” program) promote third-country nationals’ civic and community participation.

1.2.6 Useful Links (GR)

- [Ministry of Labor and Social Affairs](#)
- [Ministry of Education & Religion](#)
- [ΕΣΠΑ 2014-2020](#)
- [TAME](#)

1.3 POLICY FOR SOCIAL INTEGRATION (ITALY)

1.3.1 The National Strategy

The Italian national strategy links respect for the rules and control of migration flows with the integration of foreigners and the reception of asylum seekers, ensuring public order and security. This represents, at the same time, the challenge facing a modern, multi-ethnic society.

To be specific, Italy manages its migratory flows from countries that are not part of the European Union through specific migration policies, capable of regulating both reception and integration, with the aim of also helping to combat irregular immigration.

1.3.2 The Italian model for social integration



As of 13 December 2019, the Ministry of Labour and Social Policies, one of the Italian government ministries responsible for labour policies and employment development, was given the additional function of regulating the migration phenomenon and implementing integration policies for foreigners. In particular, the General Directorate for Immigration and Integration Policies has its main objective:

- To promote and take care of initiatives relating to active labour policies and the involvement of the competent services in activities for the integration and reintegration of foreign workers into the labour market;
- to promote initiatives to foster the social integration processes of migrants, carrying them out in cooperation with the regions and local authorities;
- to coordinate policies for the social and labour integration of migrants, and promoting initiatives to prevent and combat discrimination, xenophobia and racism;
- managing financial resources for migration policies;
- to take care of the development of international cooperation in the field of prevention and study activities on social and employment emergencies and relations with international bodies for matters within its competence.

1.3.3 Action pillars and policy measures of the National Strategy

Italy is historically known to be a country of emigrants. According to a study published in the book “*Un secolo di emigrazione italiana (1876-1976)*”, between 1876 and 1976 around 24 million Italians left, heading mainly for the United States of America (5.691.404 people), France (4.117.394), Switzerland (3.989.813), Germany (2.452.587) and Argentina (2.969.402)¹. During the 1960s, while the emigration of Italians abroad was still a very relevant factor, it was precisely at that time that, attracted by the improved lifestyle due to the economic boom the country was experiencing, the first settlements of foreign workers began to take place. However, it was not until the 1980s that we began to have a legislative reference on the subject.

There are two main pillars of legislation that currently regulate migration flows and deal with immigration in Italy: the “**Consolidated Immigration Act**” and the “**Flows Decree**”.

The Consolidated Immigration Act dlgs No 286/1998

The general outlines of public policies on immigration in Italy are contained in Law No 40/1998 (so-called 'Turco-Napolitano Law'), later consolidated in Legislative Decree No 286 of 25 July 1998, the Consolidated Immigration Act and the Status of Foreigners.

The Consolidated Immigration Act was implemented by Decree No. 394 of 31 August 1999²

It therefore represents a cornerstone of the Italian immigration system, as it establishes both the rights and the duties of the legally resident foreigner, who is placed on an equal footing with the Italian citizen in terms of both civil and labour rights.

The “Flows Decree”

The Flows Decree represents the administrative act by which the Italian government periodically establishes how many non-EU foreign citizens may enter Italy for work reasons.

It has been approved periodically since 2001, based on Law no. 40/1998 (the so-called Turco-Napolitano Law) and Article 21 of the Consolidated Immigration Act.

The regulation of entry flows into Italy provides for two steps:

¹ Source: Francesco Balletta (Author), Anna M. Birindelli (Author), G. Rosoli, 1 January 1978, "Un secolo di emigrazione italiana (1876-1976)", Rome, Centro Studi Emigrazione. The statistical data were extrapolated from the official [Istat](#) website.

² **DECREE OF THE PRESIDENT OF THE REPUBLIC of 31 August 1999, No. 394:** Regulations on the implementation of the Consolidated Text of the provisions governing immigration and regulations on the status of foreigners, in accordance with Article 1, paragraph 6, of Legislative Decree No. 286 of 25 July 1998.

- a three-year document (so-called Documento Programmatico) to plan the migratory flows entering Italy over the course of 3 years;
- a decree (Flows Decree) of the President of the Council of Ministers to periodically plan, by 30 November of the year preceding the reference year, the maximum quotas of foreigners to be admitted to Italian territory (for subordinate, subordinate seasonal and autonomous work).

The last flows decree, relating to the year 2021, was issued on 21 December 2021: *DECREE OF THE PRESIDENT OF THE COUNCIL OF MINISTERS on 21 December 2021*- Transitional programming of entry flows of non-EU workers into the territory of the State for the year 2021. (22A00166) (OJ General Series No.12 on 17-01-2022).

1.3.4 The basic tenets of the National Strategy



The role of the Ministry of Migration and Asylum

In Italy, the Department of Civil Liberties and Immigration of the Ministry of the Interior, one of the oldest ministries of the Italian state in existence since 1925, has the task, among others, of providing for the protection of civil rights, including those of religious denominations, citizenship, immigration and asylum.

Headquarters of the Ministry of Labor and Social Policies, Palazzo Marco Biagi, Rome

Specifically, the Immigration Department of the Ministry of the Interior defines:

- Migration policies: the state, local autonomies and private associations must promote the integration of foreign citizens who are legally in Italy;
- The modalities of access: the department specifies the requirements that the foreign citizen must meet in order to enter Italy (documentation, reason and condition of stay, availability of means both to maintain himself during the stay and to return to the country of origin, except for cases of entry for work reasons).

The head of the department, through the prefectures, then manages the reception system for asylum seekers or refugees.

The role of the Local Government Administrations

As established by the Consolidation Act on Immigration, the integration of foreigners in Italy is promoted and made possible by various local and national actors, with the commitment of all levels of government (State, Regions, Provinces, Municipalities). In Italy local authorities have a certain degree in some spheres of government, thanks to decentralization provided by the Italian Constitution and the legal changes introduced over the years.

As Elena Caneva explains in her report *The integration of migrants in Italy: an overview of policy instruments and actors*, regions can organize and coordinate the social services at the local level, and have a crucial role in providing social and welfare services.

According to her report, the first immigration law (no. 943/1986) gave important tasks to regions regarding integration. But it did not provide funding for these activities. Only in 1998 did immigration law no. 40 provide national funding for immigration policies to the regions, namely the National Fund for Migration Policies (which merged into the Fund for Social Policies in 2003).

Thanks to it, it is possible for third country nationals' to:

- attend Italian language courses offered by the Italian educational system or by NGOs and *Agenzie Formative* (private organizations which offer publicly-funded language courses
- Facilitate their job placement

On the other hand, in some Italian cities' funds have been allocated for: interventions aimed at: intercultural education (involving students, teachers, and families); training for teachers on intercultural issues; implementation of language and civic courses; support for housing needs and problems (e.g. circulation on information, provision of temporal accommodation, loans to rent a house); linguistic mediation in the public health care facilities; social services (e.g. help desks) to favour the circulation of information; cultural exchange; support to enter the labour market; and help for victims of human trafficking and asylum seekers; analysis of data on immigration to monitor the phenomenon and participation in EU project on migrants' integration.

Below, there are listed all the training options provided by the Italian state to immigrants/refugees.

- **Programme Agreement** between the D.G. Immigration and Integration Policies and INAPP for the implementation of analysis, monitoring and evaluation activities with reference to the system of integration policies addressed to third country nationals.

- **Programme Agreement** between the Ministry of Labour and Social Policies and the Ministry of Youth Policies and Sport for the definition of a multi-year plan of interventions promoting sport as a tool for dialogue, social inclusion and anti-discrimination.
- **Futurae - Migrant Enterprise Programme.** The project activities are organised along two main lines, which respond to a twofold objective of knowledge and promotion of migrant entrepreneurship. The first line envisages the creation of an observatory that carries out research on the socio-economic and financial inclusion of businesses managed by migrants, also as factors development of territories and international dynamism.
The observatory will publish a report with the results of its activities and those carried out by the Chamber network in the territories within the framework of the project.
- **Inclusion in socially vulnerable urban areas.** Among the types of actions eligible in project there are:
 - Interventions aimed at the socio-occupational integration of third-country nationals with particular regard to those residents in urban areas with high social vulnerability;
 - creation or consolidation of territorial multi-level governance actions to foster innovation in the organizational processes of services aimed at foreign citizens through an integrated approach to the planning of interventions (e.g. operational protocols with institutions and territorial stakeholders competent in the field of integration, strengthening and consolidation of territorial networks consisting of social and health care services, employment, education and training, reception and registry services, etc.);
 - inclusion of new generations and minors arriving in Italy for family reunification family reunification, also aimed at combating school drop-out, delay and segregation schooling;
 - socio-occupational inclusion of migrant women, in particular those arriving in family reunification, through learning the Italian language, education for Italian language, education to citizenship, orientation and accompaniment to access services (social, health, work). services (social, health, employment...);
 - combating housing hardship (e.g. low-threshold reception, co-housing, social concierge (e.g. low-threshold reception, co-housing, social concierge, rent guarantees, orientation services, intermediation and for access to housing) in favour of categories of migrants at risk of marginalization.
- **UPIO - United Protection for Integration Objective.** It is a project based on the activation of individual of individual socio-labour insertion destined for people characterized by vulnerability regularly residing in Italy, i.e., in accordance with current legislation, citizens holding international and humanitarian protection, of residence permits issued in special cases that

allow work activity, a residence permit for special protection, and citizens who have arrived in Italy as unaccompanied minors.

- **Programme Agreement** between the Ministry of Labour and Social Policies and UNIONCAMERE "to support the development and consolidation of migrant entrepreneurship, in order to favour inclusive growth also in terms of opportunities for the creation of new employment for foreign or Italian citizens". This programme consists of two steps:
 - The first one envisages the creation of an Observatory that carries out research on the socio-economic and financial inclusion of businesses run by migrants, also as factors of territorial development and international dynamism. The observatory will publish a report with the results of its activities and of those carried out by the Chamber network in the territories within the framework of the project. This will be accompanied by the creation of an 'online system on immigrant entrepreneurship to support institutional decision-makers' with dashboard functions and the dashboard and the implementation of the 'entrepreneur's digital drawer' with documentation of specific interest to the immigrant entrepreneur.
 - The second one involves 18 Chambers of Commerce in 25 provinces and envisages actions of: information; orientation; training; personalised assistance; assistance for the establishment of a new business also through accompaniment and access to credit; mentoring in the start-up phase; promotion and communication.

- **IMPACT - Integration of Migrants with Policies and Actions Co-designed on the Territory.** It is a project aiming at the consolidation of the Regional Intervention Plans for the integration of third-country nationals thanks to the Multi-Action Notice No. 1/2016. 20 projects have been presented with the direct involvement of 61 schools, 62 local authorities and 6 regional ANCI. The project activities respond to the need to capitalize on the networks, results and impacts generated by the previous experience, ensuring their stability and making them an integral part of regional policies for the integration of third-country nationals.

- **PLIM - Project for the Labour Integration of MigrAnts.** Through this intervention, the Directorate General for Immigration and Integration Policies promotes the implementation of Plans to Strengthen the Labour Integration of Migrants. Such plans are based on the intention to intercept and involve foreign nationals in a variety of specific and appropriate labour policies, which are projected and developed through a coherent plan that takes into account the specific needs expressed by local production systems for a total funding of 25,000,000 Euro. The proposed actions are mainly articulated through nine lines of activity that envisage:
 - The facilitation of access to services;

- Competence validation;
 - Consolidation of multilevel governance;
 - Promotion of the traceability Of ESF ROP policies;
 - The activation and enhancement of ad-hoc tools;
 - The enhancement of awareness-raising paths;
 - Innovative actions in emerging sector;
 - Systematization of models and methodologies with regional and Community resource;
 - Validation of qualifications obtained in the countries of origin.
- **Portal Migrant Integration - Living and Working in Italy.** The fundamental objective is to provide information on integration services: Italian language, housing, employment, health intercultural mediation, foreign minors and second generations. The Portal is also the national reference point for integration policies, facilitating the information link between public administrations (central and local) and private and private social and private social organizations operating in the sector.
 - **ForWork - Socio-occupational integration of asylum seekers and refugees.** Integrated actions accompanying autonomy in Italy (Piedmont Region) and Albania. In Italy, ForWork offered customised pathways to autonomy to about six hundred asylum seekers and refugees hosted in approximately eighty extraordinary reception centres in the Piedmont Region.

In order to contribute to making the beneficiaries an active and non-passive part of the social and economic system in the country of arrival, systems of identification, profiling and recognition of formal and non-formal skills (including the European Commission's interactive and multilingual Eu skills profile tool), civic and vocational training and vocational training, job search and placement services.

1.3.5 Useful Links (IT)

- [EU strategy | European Website on Integration \(europa.eu\)](https://european-union.europa.eu)
- [Common Basic Principles for Immigrant Integration Policy in the EU | European Website on Integration \(europa.eu\)](https://european-union.europa.eu)
- Martiniello, Marco. 2006. Towards a coherent approach to immigrant integration policy(ies) in the European Union. Intensive Programme “Theories of International Migration”; Liège: Liège University, August 29. Available online: <http://www.oecd.org/dev/38295165.pdf>
- [Asylum, Migration and Integration Fund \(2021-2027\) \(europa.eu\)](https://european-union.europa.eu)
- [Politiche di integrazione socio-lavorativa \(lavoro.gov.it\)](https://lavoro.gov.it)
- [Our projects \(programmaintegra.it\)](https://programmaintegra.it)

- [Governance of migrant integration in Italy | European Website on Integration \(europa.eu\)](#)

Chapter 2 EDUCATION AND EMPLOYMENT

2.1 PATHWAYS TO TRAINING/EDUCATION

As a third-countries national, knowing the Greek or Italian languages and understanding the social and cultural characteristics of the country are valuable tools that may assist immigrants/refugees in finding a job and becoming an integral part of Greek or Italian society. Immigrants/refugees can enroll in Greek or Italian language courses in the following learning centers, some of which also offer general education courses for adults (*Ministry of Migration and Asylum, 2019*).

2.1.1 Greece

Below, there are listed all the training options provided by the Greek state to immigrants/refugees.



The Migrant Integration Centers (M.I.C.)

- In the Migrant Integration Centers (M.I.C.), which operate as branches of Community Centers in municipalities, immigrants/refugees can learn the Greek language, Greek history and civilization. Trainees can enroll in Greek language courses in M.I.C. if they are a migrant, a beneficiary of international protection or an applicant of international protection.
- Some M.I.C. not only offer Greek language courses (levels A1 and A2) and Greek history or civilization courses but also provide training in computers as well as individual counseling sessions to support immigrants/refugees job search process.
- At present, eleven (11) M.I.C. operate in municipalities in Greece (Athens, Piraeus, Kallithea, Thessaloniki, Kordelio Evosmos, Thiva, Lamia, Andravida Killini, Iraklio, Lesvos).
- Services provided by M.I.C.

- M.I.C. provide information, service and counseling to third-country nationals with regards to social integration and social networking issues.
- Collaborate and refer requests to other competent associations, services or bodies (e.g., Associations of Migrants/Beneficiaries of International Protection, Non-Profit Organizations, Social Services, etc.).
- Some of the following activities are implemented in the context of M.I.C.: Lessons in Greek language, history, and culture which are offered to adults who are either migrants or beneficiaries of international protection. Intercultural activities which facilitate the co-existence between third-country children/young people and native children/ young people. Activities that facilitate third-country nationals' access to the job market.

Integration Training Centers of Project HELIOS

- The Integration Training Centers of Project HELIOS (*Program HELIOS*, 2019) are part of Project HELIOS which is implemented by the International Organization of Migration. The Integration Centers teach integration courses to those who are registered in project HELIOS, are older than sixteen (16) years of age and are not attending formal public education in Greece.
- The integration classes offered are part of an unofficial education that includes instruction in Greek language, culture, and civilization as well as European culture and civilization (cultural orientation). The Integration Centers also teach professional skills and life competencies to bolster job readiness.

Information:

6 Dodekanissou St., 17 456, Alimos, Athens

iomathens@iom.int

Website: <https://greece.iom.int>

Lifelong Learning Centers

- The Lifelong Learning Centers (LLC- ΚΔΒΜ) of the Ministry of Education and Religion provide informal education to adults. In the context of a general education curriculum, the Centers also offer Greek language lessons to migrants. The Lifelong Learning Centers were established and operate in municipalities, under Law 4763/2020.

- Immigrants/refugees can enroll in LLC (ΚΔΒΜ) classes if they are an adult, irrespective of gender, education level, country of origin, religion, residence, or age. In order to participate, they have to be interested in learning and willing to actively engage with the content of the courses.
- In order to ensure everyone's equal access, priority is given to members of vulnerable groups, migrants and residents of secluded or difficult to access geographical areas.
- Apart from Greek language lessons, immigrants/refugees can also enroll in courses of the following subject areas: finance, entrepreneurship, quality of life, environment, new technologies, language and communication, social skills and activities, civilization and art, counseling for parents, programs for vulnerable groups and Greek language lessons for migrants.

Information:

417 Acharnon and Kokinaki St., 111 43, Athens
kdvmm@inedivim.gr
<https://www.inedivim.gr/en>

The Modern Greek Language Teaching Center

- The Modern Greek Language Teaching Center of the National and Kapodistrian University of Athens offers modern Greek language lessons to natives, foreigners, repatriates and spouses of Greek nationals who have completed their secondary education (high school diploma).
- The Center teaches modern Greek as a second foreign language and offers B2 level certification (to those that are interested as well as prospective foreign students of Greek Universities). The Center also includes Greek culture and civilization issues in its curriculum for foreign students.

Information:

Panepistimioupoli, 157 84, Zografou
info@greekcourses.uoa.gr
<https://en.greekcourses.uoa.gr/>

Center for the Greek Language

- The Centre for the Greek Language which is supervised by the Ministry of Education and Religion, collaborates with the Ministry of Foreign Affairs. Its purpose is to reinforce and

promote the Greek language in Greece and abroad. It also organizes the instruction of the Greek language to natives and foreigners.

- More specifically, the Department of Support and Promotion of the Center of Greek Language:
 - Organizes certification exams in Greek language competency.
 - Conducts research programs that relate to the instruction of Greek as a second foreign language.
 - Provides supporting teaching materials for theory and practice.
 - Offers direction to ensure alignment of teaching materials and content with certification exams. It also provides direction for the development of teaching syllabi.
 - Provides reliable information on certification exams.
 - Offers a public discussion forum for Instructors.

Information:

1 Karamaouna St. & Skra Square, 551 32 Kalamaria, Thessaloniki

Center for Greek Language: centre@komvos.edu.gr

Exams: ellinomatheia@komvos.edu.gr

<https://www.greek-language.gr/certification/index.html>

Non-Government Organizations

- Non-Government Organizations or/and other bodies, foreign organizations, entities representing third-country nationals may also offer lessons in Greek language as well as informal general education courses for adults. Indicatively, view below:
 1. [BABEL-Outline of services](#)
 2. [ACCMR-Athens Coordination Center for Migrant and Refugee Issues of the municipality of Athens](#)
 3. [Refugee.Info](#)

Second Chance Schools

- For immigrants/refugees who are eighteen (18) years of age or older, have completed six years of Primary Education, but have not completed the first three years of Secondary Educatory (which are obligatory) they can enroll in Second Chance Schools (article 67, law 4763/2020) to complete your Junior High School education. These Schools offer preparation courses for the Junior High School diploma exam (diploma for first three years of High School). They also provide Greek language courses to migrants and refugees.

Information:

417 Acharnon and Kokinaki St., 111 43, Athens
 kdvm@inedivim.gr
<https://www.inedivim.gr/en>

Below you will find the options you have according to your age, the level of your Greek language and your interest (Refugee Info, n.d.):

- **Vocational high school (EPAL):** To be eligible you need to be over the age of 16 and employed, or an adult. Classes focus on Technology and Services and are taking place in the evenings or mornings. After 4 years of studies, you will get a Vocational Lyceum Graduation Certificate. There are reception classes in these schools.
- **Lyceum (GEL):** Lyceum school starts on mid-September and ends on mid-June. Lessons end in late May so that the students will be able to study for their examinations in June. Admitted students can have a maximum age up to 20-year-old, while must have Gymnasium Certificate or Lower Secondary Education School Certificate or its international equivalent. The Evening Lyceum (Esperino) is for both adult students and underage working students lasts 3 years since 2020–2021 academic year. After having completed the 3rd grade, the graduates of the Lyceum are awarded the qualification (Apolytirio Lykeiou). There are reception classes in these schools.
- **OAED Apprenticeship School (EPAS):** This is a 2-year vocational school where you get technical training, you get paid and you are insured. To enroll, you need to be from 16 to 23 years old and have already completed at least one year of upper secondary education in Greece in a Lyceum or in an EPAL. There are morning and evening classes, depending on the school. The admission period is usually during the summer. A committee will examine your application and will take into account not only your previous school grades but also your social and financial situation, giving priority to students who are more vulnerable and don't have a stable and secure family income. EPAS schools are managed by the Greek employment authority, OAED, where you can ask for more information. You can find your closest OAED office on this database here (in Greek). There are no reception classes in these schools. This means that, if you get accepted, you will need to speak at least some Greek to be able to attend courses.

What documents do I need?

The documents you will need to have are:

1. Your Pre-Registration card, Full-Registration card or a Residence Permit.
2. Proof of residence. (If you live in a private apartment, you can take an electricity bill as proof of address. If you live in a camp or in urban accommodation provided by an NGO, the managers of your camp or your apartment should provide a proof of address for you. Otherwise, find out how to get proof of your address here.
3. Your tax number (AFM), and access codes for the online TAXIS net platform.

Some schools may ask for additional documents. The registration process differs from school to school and changes quite often, so it's better to go to the school of your choice first and ask specifically what other documents you may need to have.

How can I enroll?

The enrollment process also varies from school to school. Application procedures can be quite complex and places are limited. Greek students also find it difficult to find a place, since there are only a few vocational schools across Greece.

2.1.2 Italy

In Italy refugees and migrants have the same rights to education as all Italians. In fact, Article 34 of the Italian Constitution states that:

Schools are open to everyone. Primary education, given for at least eight years, is compulsory and free of tuition. Capable and deserving pupils, even if lacking financial resources, have the right to attain the highest levels of education. The Republic furthers the realization of this right by scholarships, allowances to families, and other benefits, to be assigned through competitive examinations.

It is recognized that the right to study is important and, as states Article 26 of the Universal Declaration of Human Rights, «*education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms*».

Below, there are listed all the training options provided by the Italian state to immigrants/refugees.

Children and adolescents

Italian law states that all children and adolescents, irrespective of their status, have the right and the obligation to go to school until the age of 16. They must therefore register and attend school regularly. Moreover, when a foreign citizen applies for enrolment, the same documents are required as for Italian children. The application for enrollment in schools at all levels must be filled in online through the

website of the Ministry of Education. In order to enroll, it is necessary to use one of the following digital identities SPID (Public system of digital identity), CIE (electronic Identity card), eIDAS (electronic Identification Authentication and Signature) and to apply for authorization. Enrolment must be carried out by the parent or person exercising parental responsibility.

Education for adults

People older than 16 with a valid permit of stay have the right to go to schools for adult. Classes can take place either at public schools at night or at Provincial Centres for Adults Education (CPIA) where they can learn Italian.

Migrants and refugees can enrol directly at the CPIA of their choice for Lower secondary school or Upper secondary school. In order to enrol in an Upper secondary school, they need a lower secondary school qualification obtained in Italy or abroad, which it can be legally recognized.

Access to Universities

The possibility for asylum seekers to enrol in universities may vary, because of the fact that few universities currently allow them to complete full enrolment, for example the university in Messina. But it is more common for them to be allowed enrol under condition, that is they can enrol when they are recognized their refugee status.

Nevertheless, there are universities which encourage various initiatives for receiving refugees, people with migration backgrounds among students, professors etc. For instance, we may talk about Uninettuno which is located in Rome. With regard to the reception of migrants the international telematic university (Uninettuno) has created an internet portal **Education without boundaries**. It is the only University in the whole world where teaching and learning are carried on in five languages (Italian, French, English, Arab, Greek). Thanks to its international experience, this university made out of internationalization an active instrument for cooperation, and that allowed to plainly create the **“University for Refugees - Education without Boundaries”** to let refugees and immigrants access the University from anywhere across the world.

As the website states:

This tool makes it possible the recognition of educational qualifications, previously earned by refugees and migrants in their countries of origin, and the recognition of their professional competences in order to facilitate their access to our university's degree, master's and vocational training courses.

It is the first tool in the world, realized in English, French, Italian and Arabic, allowing refugees and immigrants to access and continue their university education or enrol for vocational training and retraining courses; studying in the different languages of the hosting countries; spread language and Arab World culture courses among the citizens of the hosting countries; promote knowledge about the regulations and the laws that govern reciprocal rights and duties.

Moreover, refugees may have their qualification recognized, even if they cannot request their documentation from the authorities of their country of origin. Depending on their individual condition, there are different procedures:

- **Statement of Comparability**, issued free of charge by [CIMEA](#) – the Information Centre on Academic Mobility and Equivalence – to refugees via its own service of certification of qualifications – [Diplome](#).
- **Statement of Validity** issued by [The Ministry of Foreign Affairs and International Cooperation \(MAECI\)](#), through a specific request service for refugees and holders of subsidiary protection.
- **EQPR** ([European Qualification Passport for Refugees](#)): the Council of Europe (COE) has developed an evaluation procedure for cases in which the documentation is incomplete or even absent.

Useful links

- [Iscrizioni on line - Ministero dell'Istruzione](#)
- [Education - UNHCR Italy](#)
- [University for Refugees - The Project Education Without Boundaries \(universitaperrifugiati.it\)](#)

2.2 PROFESSIONAL COUNSELING (GREECE)

Job counseling is offered in the form of individual counseling sessions with the purpose of helping third-country nationals find jobs. In these sessions, relationships of trust are developed between counselors and advisees. Counseling is practiced in an organized and systematic manner by experts in professional counseling.

In individual counseling sessions, the unique characteristics, strengths, concerns and ambitions of each individual are brought to light and taken into account in forming and providing professional advice and direction. These sessions help third-country nationals with different aspects of the job application

process, such as how to create or improve their curriculum vitae, how to use job searching techniques and how to prepare for job interviews.

Further, important services and information are provided, such as contact with prospective employers and information on employee rights, hiring processes and available training programs.

Local Public Employment Services (KPA2) of OAED

- Local Public Employment Services (KPA2) of OAED. The OAED organization helps combat poverty, helps unemployed individuals find jobs while providing employers with educated and trained personnel. The KPA2 program of OAED operates on a local level and unemployed individuals may visit Centers according to their residential area in order to receive professional counseling and information on finding jobs.

Information:

8 Ethnikis Antistaseos St., Alimos, Athens, 17 456

Contact via email KPA2

<https://www.oaed.gr/epikoinonia>

2.3 PROFESSIONAL COUNSELING (ITALY)

As far as counseling job is concerned, the full list of organisations providing integration services is available on the website of the Ministry of Labour and Social Policies (*Politiche Di Integrazione Socio-Lavorativa*, 2019) which manages a national register. The most relevant national organisations are:

- **The national network of socio-cultural associations** (*ARCI*, n.d.). Its fields of interventions range from counselling and labour market support to social services, intercultural dialogue, language courses and civic education.
- (*Diaconia Valdese*, n.d.) provides integration and support services for asylum seekers and refugees in seven regions.
- Migrant association (*ANOLF – Associazione Nazionale Oltre Le Frontiere*, n.d.). Linked to the trade union CISL (Italian Confederation of Trade Unions, it provides counselling and orientation and training services to promote migrants' rights as well as legal assistance for labour disputes or other work-related issues.
- Programme integra carries out projects aimed at promoting social inclusion of migrants and refugees; encouraging cooperation, knowledge, innovation among social professionals and counseling job.

One of the projects which manages support services such as counseling job is the **Management of the Migration, Asylum and Social Integration Center:**

- The Migration, Asylum and Social Integration Center of Rome Municipality is a polifunctional space dedicated to migration issues, international protection, social inclusion and reception, financed by Social policies department of Rome Municipality. Programme Integra manages support services addressed to migrants, such as social and legal counseling, job orientation and social mediation in the field of housing. Furthermore, Programme Integra organizes training courses addressed to social operators, conferences, raise-awareness activities, and manages the secretariat of Public Registry of Intercultural Mediators of the Rome Municipality, and the information website www.programmaintegra.it, on migration and asylum issues.

2.4 ACCESS TO THE GREEK LABOUR MARKET

Up to the end of 2019, asylum seekers had access to the labour market as employees or service or work providers from the moment an asylum application had been formally lodged and they had obtained an asylum seeker's card. Applicants who had not yet completed the full registration and lodged their application (i.e. applicants who were pre-registered), did not have access to the labour market. The average time period between pre-registration and full registration across mainland Greece (registration via Skype) was 44 days in 2019. Relevant data on the time between pre- and full registration for 2020 are not available up to the time of writing.

The new law specifies that access to employment shall be "effective". As observed, in 2018, by the Commissioner for Human Rights of the Council of Europe, access to the labour market is seriously hampered by the economic conditions prevailing in Greece, the high unemployment rate, further obstacles posed by competition with Greek-speaking employees, and administrative obstacle in order to obtain necessary document, which may lead to undeclared employment with severe repercussions on the enjoyment of basic social rights. These findings remain valid, amid a minimal decrease in the unemployment rate in Greece from 16.8% in Q4 2019 to 16.2% in Q4 2020. Higher unemployment rates were reported for persons aged up to 29 years old (29.6% for age group 25-29, 34.3% for age group 20-24 and 44.7% for age group 15-19), while overall the highest unemployment rate was recorded amongst women (19.9% as opposed to 13.3% for men).

Difficulties in accessing the labour market continued being marked for applicants residing in mainland camps and/or informal accommodation. As of the end of 2021, less than 50% of the resident adult population (9,707 out of 15,793) had managed to obtain an AFM (Taxation number), and even less of the residents above 15 years of age had managed to obtain an unemployment card from OIAD (9.97%).

In addition, both asylum seekers and beneficiaries of international protection have continued to face significant obstacles in opening bank accounts, including those dedicated for the payment of salaries, which are a precondition for payment in the private sector (JMD 22528/430/2017). The four major banks in Greece have repeatedly refused to open bank accounts to asylum seekers, even in cases where a certification of recruitment is submitted by the employer. “In fact, this policy offends against the spirit and the letter of the law, excluding thus the asylum seekers from the labour market. At the same time, employers willing to recruit asylum seekers are discouraged because of this significant barrier or, even when hiring them, face the risk of penalties”, as highlighted by the civil society organization Generation 2.0 (“When the Greek Banks Deprive Asylum Seekers of Their Right to Work,” 2019, #).

2.5 ACCESS TO THE ITALIAN LABOUR MARKET



According to the report of The *Association for Juridical Studies on Immigration (ASGI)*, a membership-based association focusing on all legal aspects of immigration, in accordance with Article 22 of the

Reception Decree an asylum seeker can start to work after 60 days from the moment he or she lodged the asylum application. Even if he or she starts working, the asylum seeker permit cannot be converted into a work or residence permit.

Despite the fact that the law makes a generic reference to the right to access to employment without indicating any limitations, and albeit being entitled to register with Provincial Offices for Labour, in practice asylum seekers face difficulties in obtaining a residence permit which allows them to work. This is due to the delay in the registration of their asylum applications, on the basis of which the permit of stay will be consequently issued, or to the delay in the renewal thereof.

The residence permit issued to refugees and beneficiaries of subsidiary protection enables them to have access to work and to public employment, with the only admitted limitation being positions involving the exercise of public authority or responsibility for safeguarding the general interests of the State.

In order to access the Italian labour market, citizens from non-EU-countries can access it:

- directly in Italy, if already have a regular residence permit and they satisfy some other requirements provided for by law
- or from abroad, within the framework of entry quotas established annually in accordance with the Flow Decrees (except in certain particular cases of entry outside the quotas).

Non-EU citizens are allowed to enter Italy for subordinate work (including seasonal) and self-employment only within the maximum amount of entry quotas established annually by specific decrees on management of entry flows for work reasons, with exception of some professional occupations that don't follow the quota system. The main regulations on entry and stay in Italy for work reasons are currently provided by the Legislative Decree of 25 July 1998, no. 286, and subsequent amendments and additions "Consolidated Act of the provisions concerning immigration and the rules on the conditions of foreign nationals" (article 22 et seq.).

Out of the 207,452 applications submitted in the first procedure, as of 2 November 2021, only 27,823 permits to stay were issued by the competent Questura, 13% of the total number of applications. The cases examined at the end of October were 78,897, about 38% of the total and the number of rejections was very high, equal to 11,405, meaning about 5% of the total cases examined. Among the rejected cases there were also cases of asylum seekers induced to renounce the asylum application to access the regularization procedure.

As for the second procedure, out of 13,000 applications submitted, as of 2 November 2021, 10,000 workers had obtained the permit to stay.



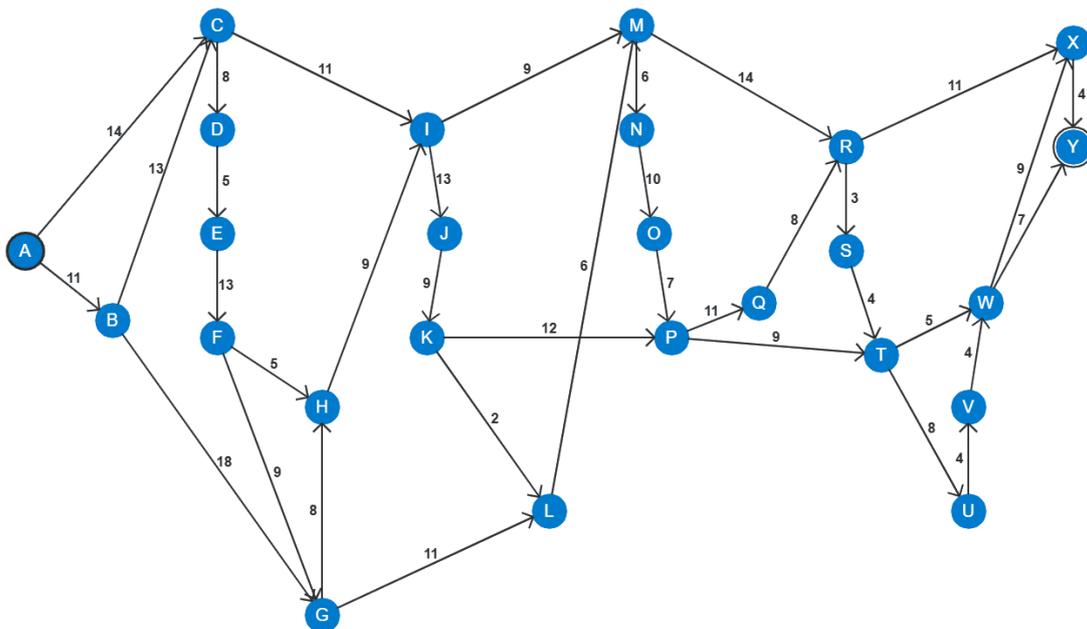
Erasmus+
Ανοίγει δρόμους, αλλάζει ζωές.

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Part II ALGORITHMIC THINKING

Logic and algorithms are essential to algorithmic Thinking (AT). Humans already have an innate, intuitive understanding of both logic and algorithms. On the other side, they are both mathematical concepts in nature. Consequently, each has its own set of rules, procedures and definitions, which are very precise and systematic. That means we can't rely solely on our intuition when dealing with these topics, otherwise, we'll make mistakes. The best way to overcome this is to learn the precise, yet difficult core concepts.

Research exists that shows us where newcomers tend to make mistakes (Pane, 2001). We'll focus on elements relevant to getting teachers and/or trainers into the habit of thinking logically and algorithmically. By the end of this part, readers will have learned how to apply logic and algorithms to problem-solving. With some practice, they should become second nature.



Chapter 1 LOGICAL THINKING

1.1 WHAT IS “LOGIC”?

Logic is a system used for distinguishing between correct and incorrect arguments. By ‘argument’, we are referring to the philosophical idea of an argument; namely a chain of reasoning that ends up in a conclusion (Beecher, 2017).

Logic includes a set of principles that, when applied to arguments, allow teachers to demonstrate what is true. Teachers need no special training to begin doing this, as this classic introductory example of a logical argument demonstrates:

1. Yannis is a man.
2. All men are mortal.
3. Therefore, Yannis is mortal.

Even those of teachers without philosophy degrees understand this argument. They perform this particular brand of reasoning all the time. However, teachers don’t always carry it out correctly, which can lead them to form wrong conclusions. And since they mostly use computers essentially to automate their reasoning for teaching, they must learn to perform logic correctly before writing a computer solution or preparing a learning material.

In a sense, applying logic is a way of developing and testing a hypothesis. Using this way of thinking, applying logic assumes teachers already know at least some things for sure and allows them to use that knowledge to arrive at some further conclusions.

In a logical argument, each individual thing you already know (or assume) is called a premise. A premise is like any ordinary statement that can be evaluated to obtain an answer of ‘true’ or ‘false’. A premise, therefore, has a truth value. In the “Yannis” example, premises fit this requirement. It is either true or not that all men are mortal. The same goes for whether “Yannis” is a man or not. Other forms of expression, like questions or commands, can’t be premises to an argument. It’s neither true nor false to say ‘Order a sandwich!’ or ask ‘How old are you?’, for example.

Once all the premises are stated, the next step is to analyze them and react accordingly with a conclusion. Most of the magic lies in this step and this is what we will focus on.

1.2 INDUCTIVE VS DEDUCTIVE ARGUMENTS

It's important to realize that some logical arguments are stronger than others. In fact, teachers can categorize arguments based on their certainty. The two best-known categories are deductive and inductive.

A deductive argument is the strongest form of reasoning because its conclusion necessarily follows from its premises (so long as it has been constructed properly and the premises are incontrovertibly true). We've already seen an example of deductive reasoning: the assessment of "Yanni's" mortality. While deductive arguments are strong, they have very strict standards, which makes them hard to construct. A deductive argument can fail in one of two ways.

First, one of its premises could turn out to be false. For example:

- i. Claire is a dog.
- ii. All dogs are brown.
- iii. Therefore, Claire is brown.

Premise 2 is false: not all dogs are brown. Even though the argument follows the exact same form as the "Yannis" example, it fails because at least one of its premises is false. Any argument with false premises fails. In computer jargon, this is an example of 'garbage in, garbage out'.

Teachers can express the form of an argument by substituting symbols for objects. This helps when trying to work out if reasoning is valid. The form of the "Yannis" example is: 'A is a B; All Bs are C; Therefore, A is C.' We'll see later how to handle logic symbolically.

The second way a deductive argument fails is when the conclusion doesn't necessarily follow from the premises. For example:

- i. All tennis balls are round.
- ii. The Earth is round.
- iii. Therefore, the Earth is a tennis ball.

This argument fails because of faulty logic. Yes, all tennis balls are round, but so are lots of other things. In symbolic terms, this argument follows the form, 'All As are B; C is B; Therefore, C is an A', but since this is in an invalid form, the argument is automatically invalid too.

In reality, deductive arguments are relatively rare. Teachers will usually encounter them only when the knowledge they are dealing with is nice and neat. However, the real world often presents us with

knowledge that's patchy, messy or provisional. Real-life issues are often nuanced. For this, we have inductive reasoning, which deals in probabilities rather than hard, black and white rules.

The premises in an inductive argument are not unquestionably true. Rather, we have some level of confidence in them. The form of the argument doesn't guarantee that the conclusion is true, but it probably results in a trustworthy conclusion. For example:

- i. A bag contains 99 red balls and one black ball.
- ii. 100 people each drew one ball from the bag.
- iii. Sarah is one of those 100 people.
- iv. Therefore, Sarah probably drew a red ball.

This is a perfectly fine inductive argument, so long as you acknowledge the aspect of probability involved.

These aspects of reasoning are important in AT when computers are involved. The answer a computer gives is only as reliable as its reasoning, and since a computer is automating the reasoning, it's teachers' responsibility to make sure:

- i. that reasoning is valid;
- ii. teacher give the computer reliable input;
- iii. teachers know how to interpret what conclusion the computer reports, that is, is the result unquestionably true (the reasoning was deductive) or probably true (the reasoning was inductive)?

1.3 BOOLEAN LOGIC

Even though much of our reasoning is inductive, computers are not well equipped to deal with shades of grey. Their binary nature makes them more apt to deal with black and white issues. In order to instruct computers to make logical decisions, we need a system of logic that maps well onto this way of thinking. Boolean logic is such a method. It's a form of logic that deals with statements having one of only two values: true or false (usually). Different corresponding values could be used in other contexts: 1 or 0 for example, on or off, black or white.

1.3.1 Propositions

Statements in Boolean logic are also known as propositions, which have several basic properties.

First, a proposition can only have one value at any one time. In other words, a single proposition can't be both true and false simultaneously. There is no way to express levels of certainty. True means true; false means false. Consequently, teachers should keep in mind what was said earlier about deductive and inductive arguments: whereas real-life problems often present us with probabilities, the basic Boolean world deals in certainties. Some of teacher's efforts will go into mapping real-world, grey areas onto Boolean black and white.

Second, propositions must have clear and unambiguous meaning. For example, a statement like: *'It is travelling fast'*, can certainly be evaluated as either true or false. However, it's ambiguous as stated. If 'it' is a car travelling at 150 mph along the motorway, that's certainly fast. But if 'it' is a spacecraft travelling towards Mars at 150 mph, that's undoubtedly slow.

Third, it's possible to combine individual propositions to make more complex ones (called compound propositions). For example, *'Jenny is wearing the shirt and the shirt is red.'* This is helpful because we often want to evaluate several statements before reaching a conclusion. We make compound propositions by connecting single propositions together using logical operators.

1.3.2 Logical operators

Imagine you say, 'If the weather is sunny and I'm on holiday, then I'm going to lie in the garden.' You've just used logical operators. That statement contains two propositions, which serve as conditions for whether, or not, you decide to lounge on the grass:

- i. The weather is sunny.
- ii. You're on holiday.

If both are true, then you can lie in the garden. If either of them is false (say, the weather is lousy or you have to go to work), then sunning yourself is not an option. That's because you joined them using the logical operator AND, which demands that both propositions should be true for the conclusion to be true.

Many different logical operators exist. It's worth looking at the most important ones in more detail because, even though we use them daily in informal speech, they have specific meanings in logic that occasionally run counter to our intuitive understanding.

To provide illustrative examples, we'll use the operators to describe the rules of a simple game: Noughts and Crosses.

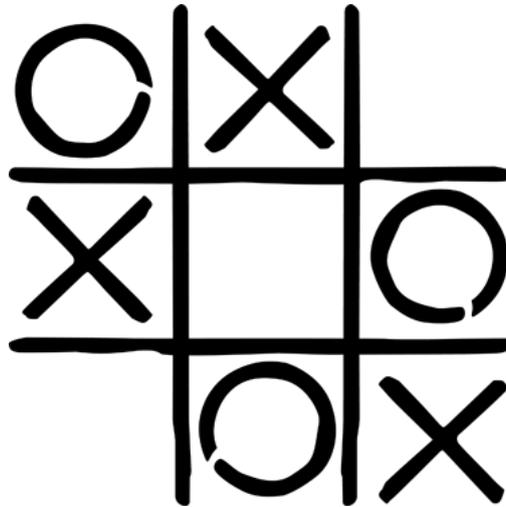


Figure 1 Noughts and Crosses

AND: the technical name for this operator is conjunction. (We just saw an example of a conjunction when we reasoned about whether to lie in the garden.) It chains propositions together in a way that all of them must be true for the conclusion to be true. If any of them are false, the conclusion is rendered false also. In classical logical arguments like we've seen so far, the presence of AND between propositions is implicit, but we can (and should) include them explicitly. So, for example:

- i. At least one square on the board is still empty.
- ii. Neither player has achieved a row.
- iii. Therefore, the game is still in progress.

This can be expressed as:

If at least one square on the board is still empty and neither player has achieved a row, then the game is still in progress.

OR: the technical name for this operator is disjunction. This operator chains propositions together in a way that at least one of them must be true for the conclusion to be true also. The only way that the conclusion is falsified is if all propositions are false. For example:

If player 1 achieves a row or player 2 achieves a row, then the game is over.

In this case, only one condition needs to be true to end the game. In fact, due to the nature of the game, a maximum of one of these conditions can be true simultaneously. OR can also be used in cases when both conditions can be true at the same time:

If a player achieves a row or all squares become occupied, then the game is over.

NOT: the technical name for this operator is negation. This operator doesn't chain propositions together itself, rather it modifies a single proposition. Specifically, it flips the truth value. Sometimes, negating a proposition can make it easier to express the chain of reasoning. For example:

If a square is not occupied, then a player may add their symbol to that square.

IMPLIES: the technical name for this operator is implication. Using this operator is to state that there is a correlation between the two statements. If the first statement is true, then the second must be true also. Keep in mind, this is a correlation not a causation. Therefore, you can't necessarily work backwards from the conclusion of an implication. Consider this:

If a player achieves a row, then the game is over.

It's true that a game ends when a player achieves a row, but it's not the only way to end a game (*Figure 2 Noughts and Crosses*). Saying 'the game is over, therefore a player achieved a row' is not always true. The game could be over because it ended in a draw.

IF AND ONLY IF: the technical name for this operator is biconditional. This behaves very similarly to implication, but a biconditional means that the second proposition is influenced solely by the first. If the first is true, the second is true. If the first is false, the second is false. No exceptions. For example:

If and only if all squares are occupied, then no more moves are possible.

In this case, we can work backwards. The only reason no more moves are possible is because all squares are occupied.

1.3.3 Symbolic logic

Logic requires precision and an absence of ambiguity, but it can be difficult to meet these requirements when using natural language. Not only can statements grow wordy and confusing, but their meaning can become almost unavoidably ambiguous.

To manage reasoning, mathematics gives us symbolic logic, which recommends using symbols instead of natural language sentences. The earlier example, 'If at least one square on the board is still empty

and neither player has achieved a row...' contains two propositions that are replaceable with symbols. If,

P = at least one square on the board is still empty

Q = neither player has achieved a row

S = the game is still in progress

then we can say:

If P and Q, then S

Not only does that reduce the clutter, but it becomes more intuitive to treat each proposition as a variable. After all, each proposition has a value that can be true or false at different times.

The operators, too, are often replaced by symbols (see Table 2.1).

Table 2.1 Logical operators and their symbols

Operator name	Symbol	Example
AND	\wedge	$A \wedge B$
OR	\vee	$A \vee B$
NOT	\neg	$\neg A$
IMPLIES	\rightarrow	$A \rightarrow B$
IF AND ONLY IF	\leftrightarrow	$A \leftrightarrow B$

Our example can then further be reduced to:

$$P \wedge Q \leftrightarrow S$$

1.4 THE 5 STEPS OF PROBLEM SOLVING

Before we talk about the stages of problem solving, it's important to have a definition of what it is. Let's look at the two roots of problem solving — problems and solutions (The 5 Steps of Problem Solving, n.d.).

Problem – a state of desire for reaching a definite goal from a present condition

Solution – the management of a problem in a way that successfully meets the goals set for treating it

One important call-out is the importance of having a goal. As defined above, the solution may not completely solve problem, but it does meet the goals you establish for treating it—you may not be able to completely resolve the problem, but you can have a goal to help.

With that understanding of problem solving, let's talk about the steps that can get you there. The five problem solving steps are shown in the chart below:

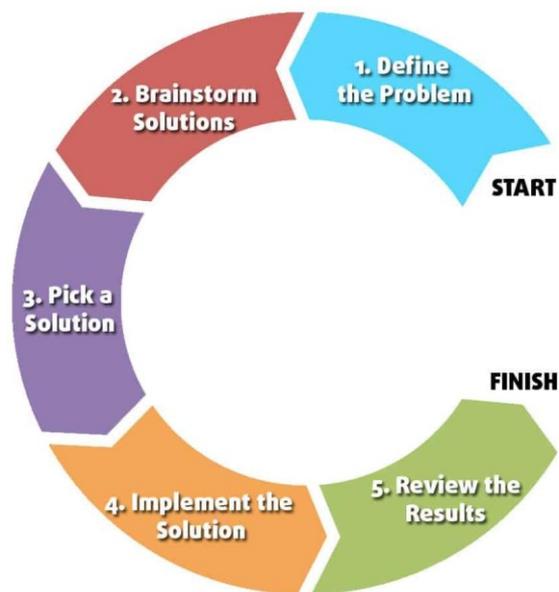


Figure 2 5 steps to problem solving

Let's explore of these steps in more detail, understanding what it is and the inputs and outputs of each phase.

1. Define the Problem

What are you trying to solve? In addition to getting clear on what the problem is, defining the problem also establishes a goal for what you want to achieve.

Input: something is wrong or something could be improved.

Output: a clear definition of the opportunity and a goal for fixing it.

2. Brainstorm Ideas

What are some ways to solve the problem? The goal is to create a list of possible solutions to choose from. The harder the problem, the more solutions you may need.

Input: a goal; research of the problem and possible solutions; imagination.

Output: pick-list of possible solutions that would achieve the stated goal.

3. Decide on a Solution

What are you going to do? The ideal solution is effective (it will meet the goal), efficient (is affordable), and has the fewest side effects (limited consequences from implementation).

Input: pick-list of possible solutions; decision-making criteria.

Output: decision of what solution you will implement.

4. Implement the Solution

What are you doing? The implementation of a solution requires planning and execution. It's often iterative, where the focus should be on short implementation cycles with testing and feedback, not trying to get it "perfect" the first time.

Input: decision; planning; hard work.

Output: resolution to the problem.

5. Review the Results

What did you do? To know you successfully solved the problem, it's important to review what worked, what didn't and what impact the solution had. It also helps you improve long-term problem-solving skills and keeps you from re-inventing the wheel.

Input: resolutions; results of the implementation.

Output: insights; case-studies; bullets on your resume.

1.5 DEFINITION & EXAMPLES OF PROBLEM-SOLVING SKILLS

Problem-solving skills help you solve issues quickly and effectively. It's one of the key skills that employers seek in job applicants, as employees with these skills tend to be self-reliant. Problem-solving skills require quickly identifying the underlying issue and implementing a solution.

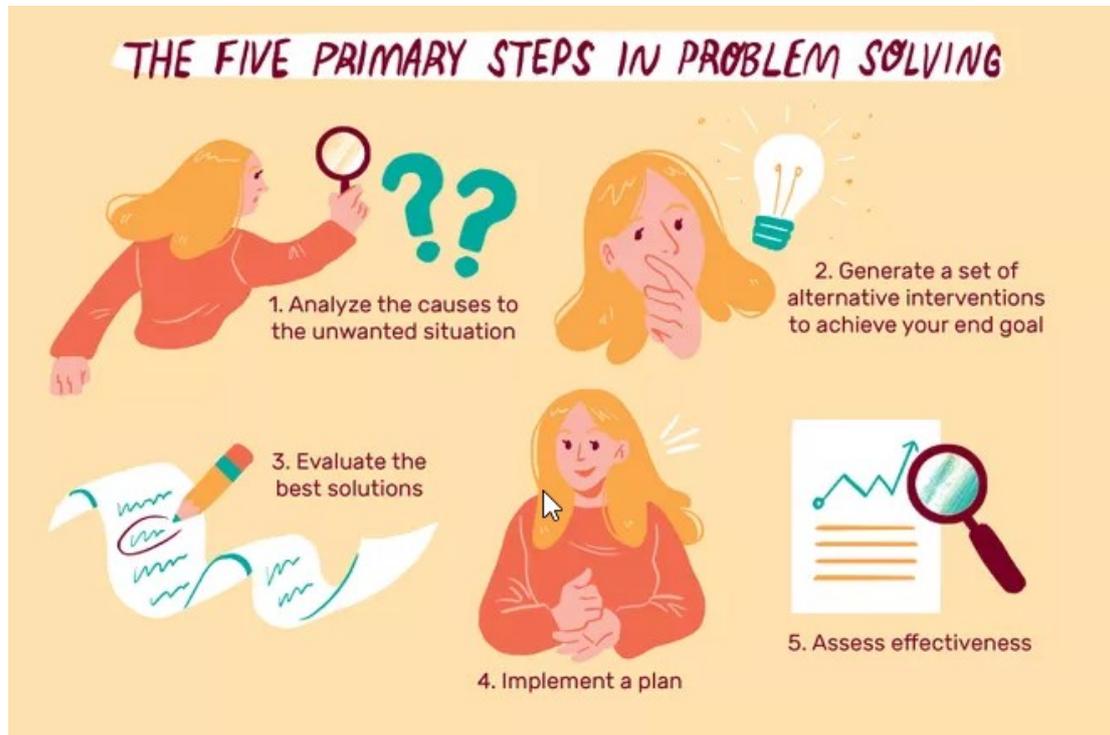
Problem-solving is considered a **soft skill** (a personal strength) rather than a hard skill that's learned through education or training. You can improve your problem-solving skills by familiarizing yourself with common issues in your industry and learning from more experienced employees (Doyle, 2020).

1.5.1 How Problem-Solving Skills Work

Problem-solving starts with identifying the issue. For example, a teacher might need to figure out how to improve student performance on a writing proficiency test. To do that, the teacher will review the

writing tests looking for areas of improvement. They might see that students can construct simple sentences, but they're struggling with writing paragraphs and organizing those paragraphs into an essay.

To solve the problem, the teacher would work with students on how and when to write compound sentences, how to write paragraphs, and ways to organize an essay.



1.5.2 There are five steps typically used in problem-solving.

1. Analyze Contributing Factors

To solve a problem, you must find out what caused it. This requires you to gather and evaluate data, isolate possible contributing circumstances, and pinpoint what needs to be addressed for a resolution.

To do this, you'll use skills like:

- Data gathering
- Data analysis
- Fact-finding
- Historical analysis

2. Generate Interventions

Once you've determined the cause, brainstorm possible solutions. Sometimes this involves teamwork since two (or more) minds are often better than one. A single strategy is rarely the obvious route to solving a complex problem; devising a set of alternatives helps you cover your bases and reduces your risk of exposure should the first strategy you implement fail.

This involves skills like:

- Brainstorming
- Creative thinking
- Prediction
- Forecasting
- Project design
- Project planning

3. Evaluate Solutions

Depending on the nature of the problem and your chain of command, evaluating best solutions may be performed by assigned teams, team leads, or forwarded to corporate decision-makers. Whoever makes the decision must evaluate potential costs, required resources, and possible barriers to successful solution implementation.

This requires several skills, including:

- Analysis
- Discussion
- Corroboration
- Teamwork
- Test development
- Mediation
- Prioritizing

4. Implement a Plan

Once a course of action has been decided, it must be implemented along with benchmarks that can quickly and accurately determine whether it's working. Plan implementation also involves letting personnel know about changes in standard operating procedures.

This requires skills like:

- Project management

- Project implementation
- Collaboration
- Time management
- Benchmark development

5. Assess the Solution's Effectiveness

Once a solution is implemented, the best problem-solvers have systems in place to evaluate if and how quickly it's working. This way, they know as soon as possible whether the issue has been resolved or whether they'll have to change their response to the problem mid-stream.

- This requires:
- Communication
- Data analysis
- Surveys
- Customer feedback
- Follow-through
- Troubleshooting

Chapter 2 ALGORITHMIC THINKING

2.1 INTRODUCTION TO ALGORITHMS

An algorithm is a set of step-by-step procedures, or a set of rules to follow, for completing a specific task or solving a particular problem. The word algorithm was first coined in the 9th century. Algorithms are all around us. Common examples include: the recipe for baking a cake, the method we use to solve a long division problem, the process of doing laundry, and the functionality of a search engine are all examples of an algorithm. Here's what baking a cake might look like, written out as a list of instructions, just like an algorithm (*What Is an Algorithm*, 2019):

1. Preheat the oven
2. Gather the ingredients
3. Measure out the ingredients
4. Mix together the ingredients to make the batter
5. Grease a pan
6. Pour the batter into the pan
7. Put the pan in the oven
8. Set a timer
9. When the timer goes off, take the pan out of the oven
10. Enjoy!

Algorithmic programming is all about writing a set of rules with a finite number of steps that instruct the computer how to perform a task. A computer program is essentially an algorithm that tells the computer what specific steps to execute, in what specific order, in order to carry out a specific task. Algorithms are written using particular syntax, depending on the programming language being used.

2.1.1 Intuition vs precision

Algorithms are tricky things. In a sense, they're intuitive concepts that have been with us for centuries, yet they only received a definition in the last hundred years or so (Knuth, 1997). It's easy to articulate them intuitively, but at the same time computer science's concept of an algorithm is multi-faceted and can take beginners some time to comprehend. Misunderstandings commonly arise (Pane, 2001, #), so we'll focus on building a solid understanding.

Before going into the hard details, let's take as our starting point the simple definition in the box above. You've very likely dealt with algorithms in this sense already. Anyone who has followed a recipe while

cooking has encountered something like this. Or anyone who went on a treasure hunt as a child. Or anyone who has assembled furniture. An algorithm is a way of making our processes explicit so that you can communicate them to someone else in a way that allows them to carry out those same steps too. These are only analogies however. Strictly speaking, algorithms perform operations on data rather than cake ingredients or coffee tables.

The earliest pioneers of computer science examined what it meant to communicate ideas to a computer. They sought a means for us to take the ideas in our heads and put them into a form that computers can understand and compute on our behalf. They discovered that our existing, intuitive ideas of algorithms were insufficient, so they took those ideas and re-formed them into the kind of clear and unambiguous form that computers require. By doing so, they made algorithms our means for giving computers instructions.

As precise as they became, algorithms were also rendered more complex, so much so that a formal description of them can stretch over several paragraphs. In our case, the best way to approach a definition is to take each property of algorithms, one by one, and explain it. Along the way, we'll use an analogy to one of our intuitive ideas of an algorithm (in this case, following a recipe) to help us understand.

2.1.2 Algorithm properties

The definition of an algorithm is complex and involves several properties. This subsection describes those properties.

Collection of individual steps

The first property to mention just restates something said earlier: an algorithm is a collection of individual steps. A recipe fits this analogy quite simply, filled as it is with steps like: 'pre-heat the oven to 180 degrees Celsius' or 'add two tablespoons of sugar to the bowl'.

Definiteness

Following on from that property is definiteness, meaning that every step must be precisely defined. Each step in an algorithm can have one and only one meaning, otherwise it is ambiguous. Similarly, chefs have come to the same conclusion, which is why they produce recipes using precise measurements instead of writing things like 'some sugar' or 'cook it for a while'.

Sequential

Algorithms are also sequential. The steps that make up the process must be carried out in the order specified. Failing to do this means that the result of executing the algorithm is likely incorrect. Think back to the analogy.

- Dicing an onion and frying an onion are different steps. Dicing an onion before you fry it has a different outcome than the reverse.
- Similarly, multiplying a number by 2 then adding 5 to it yields a different result from adding 5 first then doubling it.

Like a recipe, you must respect the sequence when running through an algorithm for it to have any meaningful result.

Detour: State in algorithms

It's worth going on a brief detour here to examine why sequence is so important to algorithms. It's all to do with state, by which I simply mean the current values of all the things the algorithm is keeping track of. As a computer progresses through an algorithm, just as you progress through a recipe, the state of things can change. Clearly sequencing the steps of an algorithm ensures that state always changes in the same way whenever the algorithm is executed.

2.2 TYPES OF ALGORITHMS

Algorithms are classified based on the concepts that they use to accomplish a task. While there are many types of algorithms, the most fundamental types of computer science algorithms are:

Divide and conquer algorithms – divide the problem into smaller subproblems of the same type; solve those smaller problems, and combine those solutions to solve the original problem.

Brute force algorithms – try all possible solutions until a satisfactory solution is found.

Randomized algorithms – use a random number at least once during the computation to find a solution to the problem.

Greedy algorithms – find an optimal solution at the local level with the intent of finding an optimal solution for the whole problem.

Recursive algorithms – solve the lowest and simplest version of a problem to then solve increasingly larger versions of the problem until the solution to the original problem is found.

Backtracking algorithms – divide the problem into subproblems, each which can be attempted to be solved; however, if the desired solution is not reached, move backwards in the problem until a path is found that moves it forward.

Dynamic programming algorithms – break a complex problem into a collection of simpler subproblems, then solve each of those subproblems only once, storing their solution for future use instead of re-computing their solutions.

Sorting Algorithms

A sorting algorithm is an algorithm that puts elements of a list in a certain order, usually in numerical or lexicographical order. Sorting is often an important first step in algorithms that solves more complex problems. There are a large number of sorting algorithms, each with their own benefits and costs. Below, we will focus on some of the more famous sorting algorithms.

- **Linear sort:** Find the smallest element in the list to be sorted, add it to a new list, and remove it from the original list. Repeat this until the original list is empty.
- **Bubble sort:** Compare the first two elements in the list, and if the first is greater than the second, swap them. Repeat this with every pair of adjacent elements in the list. Then, repeat this process until the list is fully sorted.
- **Insertion sort:** Compare each element in the list to all the prior elements until a smaller element is found. Swap these two elements. Repeat this process until the list is fully sorted.

2.3 EXAMPLES OF REAL-WORLD ALGORITHMS

Whether algorithms are used in places that aren't at all surprising, like Google, or in a manual activity that is more unexpected, like brushing your teeth, algorithms play a role in the human experience every single day (*Algorithm Examples: Definition & 6 Real World Examples, 2021*).

2.3.1 Sorting Papers

Imagine a teacher sorting their students' papers according to the alphabetical order of their first names. This type of task is similar to the function of a sorting algorithm, like a bucket sort. By looking at only the first letter of the first name, you can remove a lot of unnecessary information. This is an automated process that makes sorting more efficient.

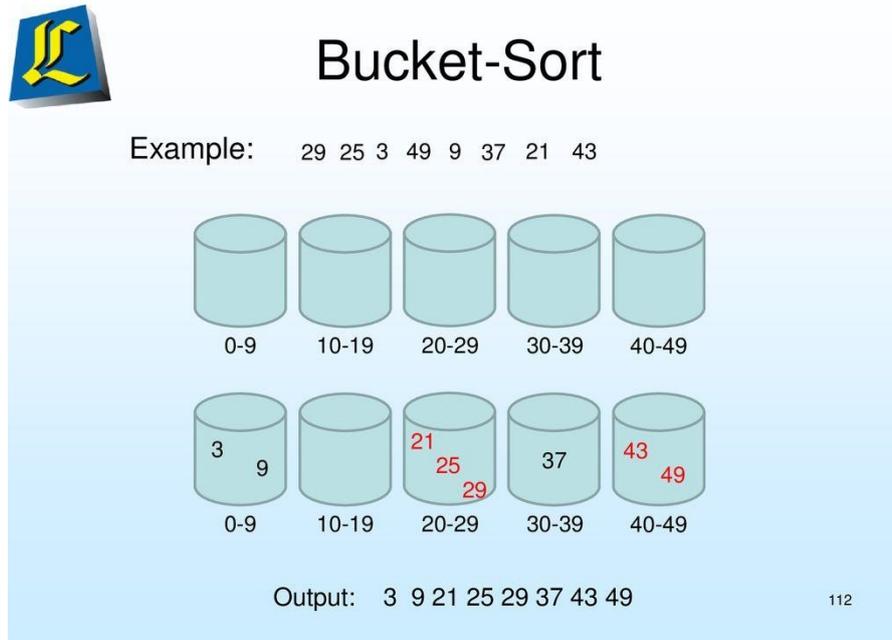


Figure 3 Bucket-sort algorithm

2.3.2 Facial Recognition

Every day we see someone we know: a loved one, a coworker, or even an eccentric neighbor. When we recognize somebody's face, we're drawing upon data we've previously collected on the size and position of that person's facial features. That information is then analyzed internally to automatically recognize others.

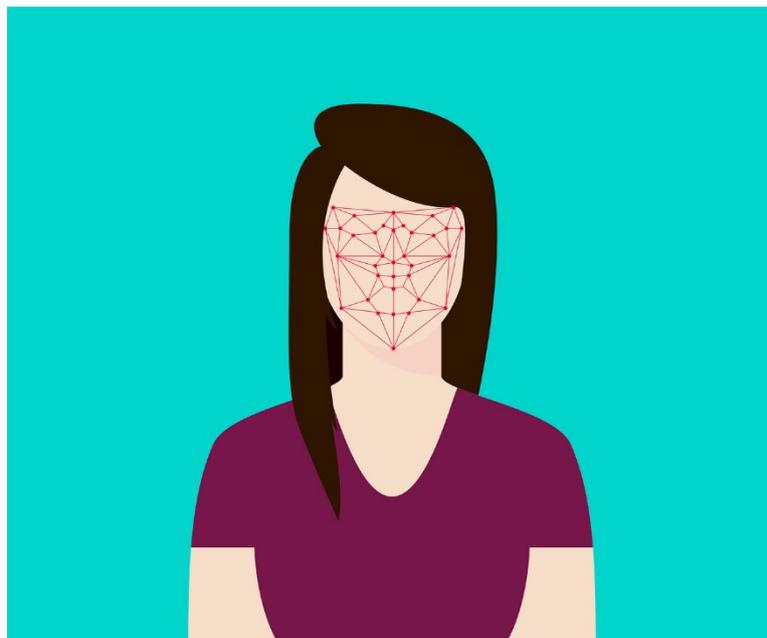


Figure 4 Facial recognition, both through people we know and through technology, is an example of a real-world algorithm

Algorithms can automate this process for computers; however, facial recognition is not perfect. In the Netflix series “Coded Bias,” Joy Buolamwini, an activist and computer scientist based at MIT (Buolamwini, 2020), discusses how algorithms used for facial recognition can be biased. This investigative series finds that facial recognition algorithms often do not recognize dark-skinned faces accurately, uncovering the need for additional work when creating algorithms based on human design.

2.3.3 Google Search

Even an action as seemingly simple as a Google search is only possible with the help of algorithms. Say, for example, you want to know if an elephant can swim. How you phrase the question to Google is the input you are asking the computer to determine.

Google doesn’t even need all the words of the question “*can an elephant swim?*” For example, try searching for “*swimming elephant*” and see what you get. You will find that immediately, the output or the results show videos of elephants swimming, followed by more on the subject. Google uses an algorithm to generate these answers without needing the entirety of the question.

2.3.4 Duplicating Outcomes

A teenage boy references a cookbook in the kitchen. Following a recipe is a good example of real-world algorithms in action. David Czechowski, Computer Science and Technology Teacher at Hyde Park Central Schools, explains this example. “*If we want to do well at a given task, it can be extremely helpful to look at previous successful examples from other people. A great daily example of this is using a recipe while cooking. Sure, you might be able to figure out how to make delicious pasta on your own through trial and error, but following a step-by-step recipe from a well-known chef helps ensure success.*”

2.3.5 Traffic Lights

Czechowski adds, “*Here’s an algorithm we frequently experience; the next time you’re in your car stuck at a red light, consider the algorithm the traffic light is executing.*”

Traffic lights are a great example of how algorithms are used in the real world, all around us.

Most traffic lights don’t automatically cycle through green, yellow, and red. Rather, there are sensory inputs that determine the signals’ timing based on the flow of traffic. The algorithm is a well-constructed, step-by-step order that directs the traffic appropriately (although it may not feel like it when you’re sitting at a red light).

2.3.6 Bus Schedules

Every weekday morning, thousands of buses criss-cross neighborhoods picking up students. Mapping out efficient bus routes is an overwhelming manual task to execute without an algorithm to automate the calculations and schedule the right students for the right addresses at the right time. This routing issue is classically referred to as “*The Traveling Salesman Problem*” (Wikipedia, n.d.) and is even used as an exercise for theoretical computer science, according to Czechowski.

Algorithms are all around us, so close and common that we don’t even recognize them as algorithms. From cooking to looking up directions to something simple like tying your shoes, finding algorithms in your day-to-day life may not be as hard as you think.

Chapter 3 ALGORITHMIC THINKING IN PRACTICE

3.1 TOWER OF HANOI

The Tower of Hanoi is a mathematical game or puzzle consisting of three rods and a number of disks of various diameters, which can slide onto any rod. The puzzle begins with the disks stacked on one rod in order of decreasing size, the smallest at the top, thus approximating a conical shape. The objective of the puzzle is to move the entire stack to the last rod, obeying the following rules (*Tower of Hanoi*, n.d.):

1. Only one disk may be moved at a time.
2. Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack or on an empty rod.
3. No disk may be placed on top of a disk that is smaller than it.

With 3 disks, the puzzle can be solved in 7 moves. The minimal number of moves **required to solve a Tower of Hanoi puzzle is $2^n - 1$** , where n is the number of disks. The puzzle can be played with any number of disks, although many toy versions have around 7 to 9 of them.

3.1.1 Iterative solution

A simple solution for the toy puzzle is to alternate moves between the smallest piece and a non-smallest piece. When moving the smallest piece, always move it to the next position in the same direction (to the right if the starting number of pieces is even, to the left if the starting number of pieces is odd). If there is no tower position in the chosen direction, move the piece to the opposite end, but then continue to move in the correct direction. For example, if you started with three pieces, you would move the smallest piece to the opposite end, then continue in the left direction after that. When the turn is to move the non-smallest piece, there is only one legal move. Doing this will complete the puzzle in the fewest moves.

Simpler statement of iterative solution

For an even number of disks:

- make the legal move between pegs A and B (in either direction),
- make the legal move between pegs A and C (in either direction),
- make the legal move between pegs B and C (in either direction),
- repeat until complete.

For an odd number of disks:

- make the legal move between pegs A and C (in either direction),
- make the legal move between pegs A and B (in either direction),
- make the legal move between pegs B and C (in either direction),
- repeat until complete.

In each case, a total of $2n - 1$ moves are made.

Equivalent iterative solution

Another way to generate the unique optimal iterative solution:

Number the disks 1 through n (largest to smallest).

- If n is odd, the first move is from peg A to peg C.
- If n is even, the first move is from peg A to peg B.

Now, add these constraints:

- No odd disk may be placed directly on an odd disk.
- No even disk may be placed directly on an even disk.
- There will sometimes be two possible pegs: one will have disks, and the other will be empty. Place the disk on the non-empty peg.
- Never move a disk twice in succession.

Considering those constraints after the first move, there is only one legal move at every subsequent turn.

The sequence of these unique moves is an optimal solution to the problem equivalent to the iterative solution described above.

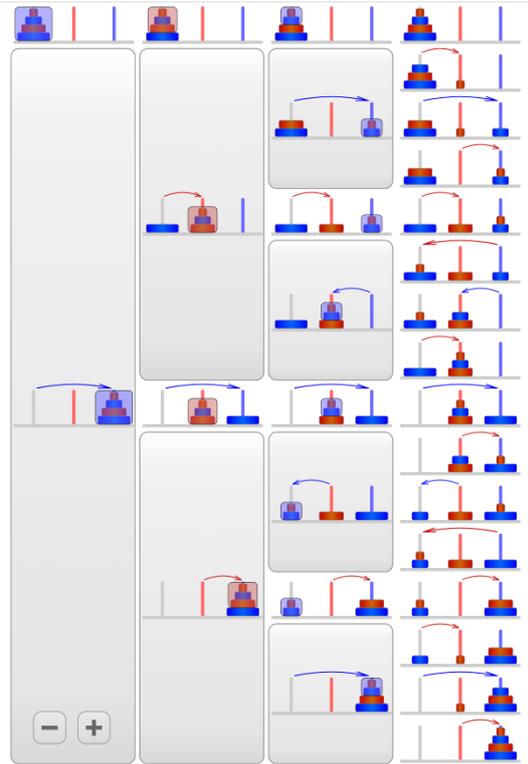
3.1.2 Recursive solution

The key to solving a problem recursively is to recognize that it can be broken down into a collection of smaller sub-problems, to each of which that same general solving procedure that we are seeking applies, and the total solution is then found in some simple way from those sub-problems' solutions. Each of these created sub-problems being "smaller" guarantees that the base case(s) will eventually be reached. Thence, for the Towers of Hanoi:

- label the pegs A, B, C,
- let n be the total number of disks,
- number the disks from 1 (smallest, topmost) to n (largest, bottom-most).

Assuming all n disks are distributed in valid arrangements among the pegs; assuming there are m top disks on a source peg, and all the rest of the disks are larger than m , so they can be safely ignored; to move m disks from a source peg to a target peg using a spare peg, without violating the rules:

- Move $m - 1$ disks from the source to the spare peg, by the same general solving procedure. Rules are not violated, by assumption. This leaves the disk m as a top disk on the source peg.
- Move the disk m from the source to the target peg, which is guaranteed to be a valid move, by the assumptions — a simple step.
- Move the $m - 1$ disks that we have just placed on the spare, from the spare to the target peg by the same general solving procedure, so they are placed on top of the disk m without violating the rules.
- The base case is to move 0 disks (in steps 1 and 3), that is, do nothing – which obviously doesn't violate the rules.



The full Tower of Hanoi solution then consists of moving n disks from the source peg A to the target peg C, using B as the spare peg. This approach can be given a rigorous mathematical proof with mathematical induction and is often used as an example of recursion when teaching programming.

3.2 SORTING SOLUTIONS

3.2.1 Bubble sort

Bubble sort is a sorting algorithm that compares two adjacent elements and swaps them until they are not in the intended order. Just like the movement of air bubbles in the water that rise up to the surface, each element of the array moves to the end in each iteration. Therefore, it is called a bubble sort.

Working of Bubble Sort

Suppose we are trying to sort the elements in ascending order. The below figure () shows up the way the bubble sort algorithm sorts an unsorted array (or set of items).

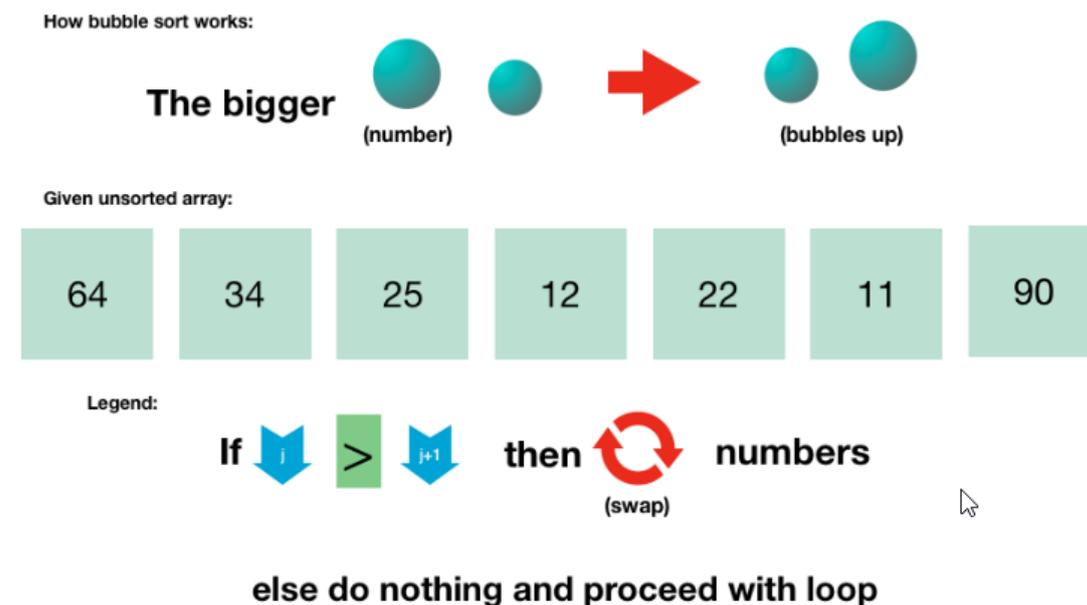


Figure 5 Bubble sort working philosophy

1. First Iteration (Compare and Swap)

- Starting from the first index, compare the first and the second elements.
- If the first element is greater than the second element, they are swapped.
- Now, compare the second and the third elements. Swap them if they are not in order.
- The above process goes on until the last element.

2. Remaining Iteration

- The same process goes on for the remaining iterations.
- After each iteration, the largest element among the unsorted elements is placed at the end.
- In each iteration, the comparison takes place up to the last unsorted element.
- The array is sorted when all the unsorted elements are placed at their correct positions.

How can we Optimize the Bubble Sort Algorithm?

In the above algorithm, all the comparisons are made even if the array is already sorted. This increases the execution time. Thus, in order to quit when everything is sorted, we use a “flag”. Initially, the flag is down and if we have to swap two elements then the flag is raised. In case where the flag remains down after a full visit, then we conclude that all items are sorted and we quite the algorithm!

3.2.2 Bucket Sorting

Bucket Sort is a sorting algorithm that divides the unsorted array elements into several groups called buckets. Each bucket is then sorted by using any of the suitable sorting algorithms or recursively applying the same bucket algorithm. Finally, the sorted buckets are combined to form a final sorted array.

Scatter Gather Approach

The process of bucket sort can be understood as a scatter-gather approach. Here, elements are first scattered into buckets then the elements in each bucket are sorted. Finally, the elements are gathered in order.

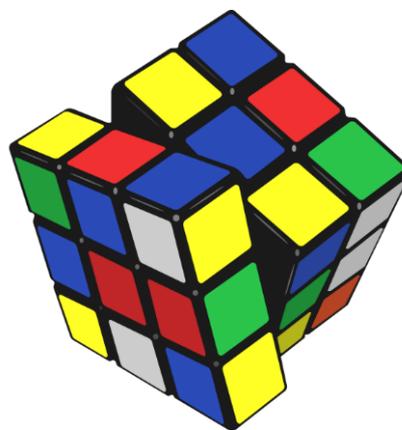


3.3 SOLVING A RUBIK'S CUBE

There are a number of different algorithms, from simple to very complicated, that exist for solving a Rubik's cube. Below is just one simple algorithm that significantly reduces the amount of time to solve this famous puzzle (*What Is an Algorithm*, 2019). First, let's specify a notation to use (similar to picking a programming language).

Each of the six faces of a Rubik's cube can be represented by the first letter of their name:

- U - up
- D - down
- L - left
- R - right
- F - front
- B - back



Each face can be turned in three different ways/directions. Using U as an example, these are represented as:

U - clockwise quarter-turn of the upper face

U' - counter-clockwise quarter-turn of the upper face

U2 - half turn in either direction of the upper face

Now, let's go through the steps in the algorithm to solve a Rubik's Cube. Feel free to grab one of your own and follow along!

Step 1: The Cross

First, flip some edges so that there is a white cross on the upper face.

Apply the following turns: **F, R', D', R, F2, R', U, R, U', R', R2, L2, U2, R2, L2.**

The cross is now solved.

Step 2: The White Corners

The edges on the white face are now complete, but the corners remain.

Depending on where the white-orange-green corner is in the puzzle, apply one of the following series of turns:

Bottom: **R', D', R, D** (repeat until the corner moves to its correct place)

Top: **R', D', R, D** (this moves the corner to the bottom; then, follow the above instructions)

Step 3: Middle Layer Edges

Flip the cube so that the white is on the bottom.

Look for an edge that is on the top face and doesn't have yellow on it.

Perform a U-turn so that the color on the front face of the edge matches with the center.

Depending on the direction that the edge could go, apply one of the following series of turns:

Left: **U', L', U, L, U, F, U', F'**

Right: U, R, U', R', U', F', U, F)

Step 4: Yellow Cross

Apply the following turns, until a yellow cross on the face appears with the yellow center: **F, R, U, R', U', F'**.

If there is an "L" shape, where the two yellow pieces showing are adjacent to each other, apply the following turns: **F, U, R, U', R', F'**.

If there is a "Line" shape, which is horizontal, apply the following turns: **F, R, U, R', U', F'**.

Step 5: Sune and Antisune

Look at the face with the yellow center.

Depending on the below contingencies, apply one of the following series of turns:

If there is only one oriented corner: **R, U, R', U, R, U2, R'** (repeat until the desired position is attained)

There is one oriented corner and one right-facing corner: **U2, R, U2, R', U', R, U', R'**

Step 6: Finishing the puzzle

Look for sets of "headlights" (two stickers of the same color in the same row, separated by a sticker of a different color).

Depending on how many there are, apply one of the following series of turns:

If there are a set of headlights on each side: **R, U', R, U, R, U, R, U', R', U', R2**

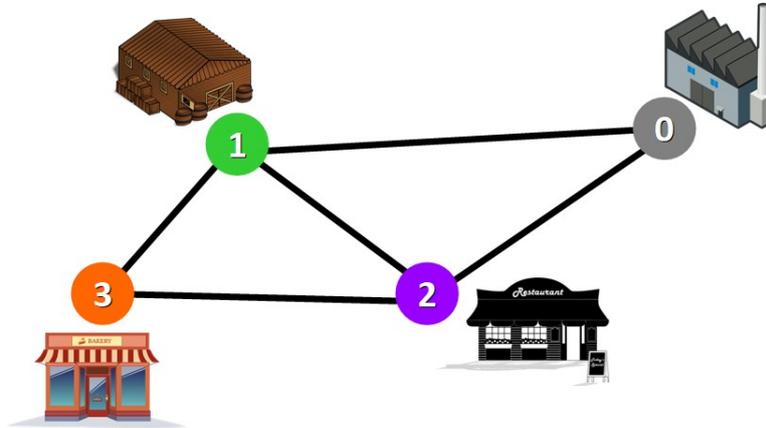
Otherwise: **R', F, R', B2, R, F', R', B2, R2**

3.4 DIJKSTRA'S SHORTEST PATH ALGORITHM

This algorithm was created and published by Dr. Edsger W. Dijkstra, a brilliant Dutch computer scientist and software engineer.

With Dijkstra's Algorithm (*Dijkstra's Algorithm*, n.d.), you can find the shortest path between places in the city (nodes in a graph). Particularly, you can find the shortest path from a point (called the "source

node") to all other points in the city, producing a shortest-path tree. This algorithm is used in GPS devices to find the shortest path between the current location and the destination. It has broad applications in industry, especially in domains that require modeling networks.



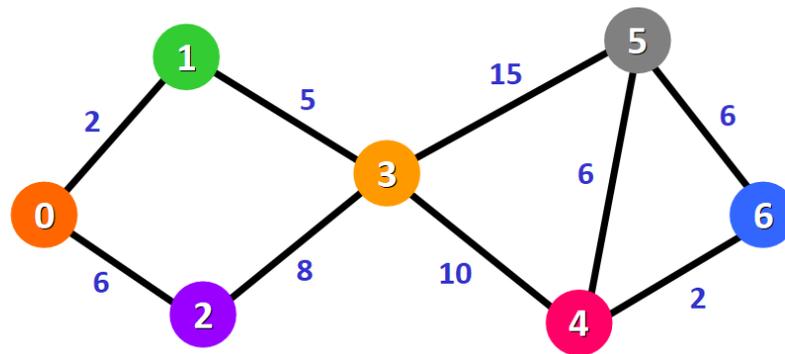
Basics of Dijkstra's Algorithm

- Dijkstra's Algorithm basically starts at the node that you choose (the source node) and it analyzes the graph to find the shortest path between that node and all the other nodes in the graph.
- The algorithm keeps track of the currently known shortest distance from each node to the source node and it updates these values if it finds a shorter path.
- Once the algorithm has found the shortest path between the source node and another node, that node is marked as "visited" and added to the path.
- The process continues until all the nodes in the graph have been added to the path. This way, we have a path that connects the source node to all other nodes following the shortest path possible to reach each node.

Example of Dijkstra's Algorithm

Let's see how it works behind the scenes with a step-by-step example.

We have this graph:



The algorithm will generate the shortest path from node 0 to all the other nodes in the graph.

💡 Tip: For this graph, we will assume that the weight of the edges represents the distance between two nodes.

We will have the shortest path from node 0 to node 1, from node 0 to node 2, from node 0 to node 3, and so on for every node in the graph.

Initially, we have this list of distances (please see the list below):

- The distance from the source node to itself is 0. For this example, the source node will be node 0 but it can be any node that you choose.
- The distance from the source node to all other nodes has not been determined yet, so we use the infinity symbol to represent this initially.

Distance:

0: 0

1: ∞

2: ∞

3: ∞

4: ∞

5: ∞

6: ∞

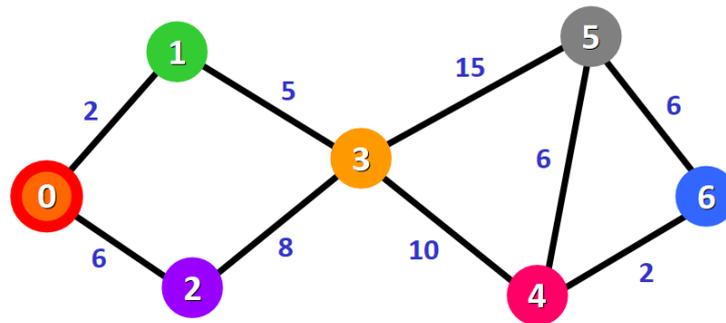
We also have this list (see below) to keep track of the nodes that have not been visited yet (nodes that have not been included in the path):

Unvisited nodes = {0,1,2,3,4,5,6}

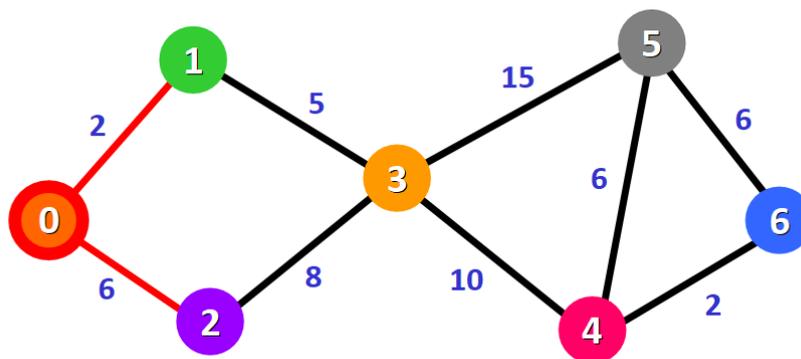
💡 Tip: Remember that the algorithm is completed once all nodes have been added to the path.

Since we are choosing to start at node 0, we can mark this node as visited. Equivalently, we cross it off from the list of unvisited nodes and add a red border to the corresponding node in diagram:

Unvisited nodes = {~~0~~,1,2,3,4,5,6}



Now we need to start checking the distance from node 0 to its adjacent nodes. As you can see, these are nodes 1 and 2 (see the red edges):



Tip: This doesn't mean that we are immediately adding the two adjacent nodes to the shortest path. Before adding a node to this path, we need to check if we have found the shortest path to reach it. We are simply making an initial examination process to see the options available.

We need to update the distances from node 0 to node 1 and node 2 with the weights of the edges that connect them to node 0 (the source node). These weights are 2 and 6, respectively:

Distance:

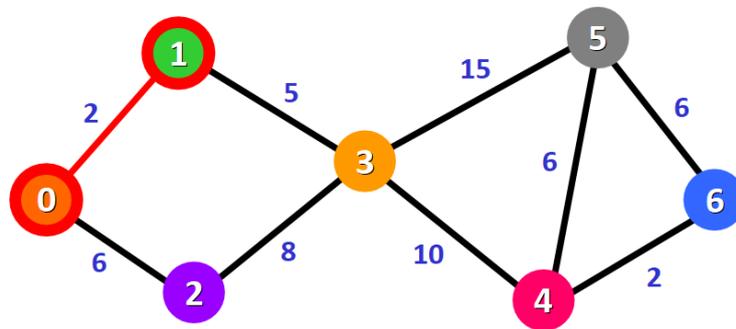
0: 0
 1: ∞ 2
 2: ∞ 6
 3: ∞
 4: ∞
 5: ∞
 6: ∞

After updating the distances of the adjacent nodes, we need to:

- Select the node that is closest to the source node based on the current known distances.
- Mark it as visited.
- Add it to the path.

If we check the list of distances, we can see that node 1 has the shortest distance to the source node (a distance of 2), so we add it to the path.

In the diagram, we can represent this with a red edge:



We mark it with a red square in the list to represent that it has been "visited" and that we have found the shortest path to this node:

Distance:

0: 0

1: ∞ 2 ok

2: ∞ 6

3: ∞

4: ∞

5: ∞

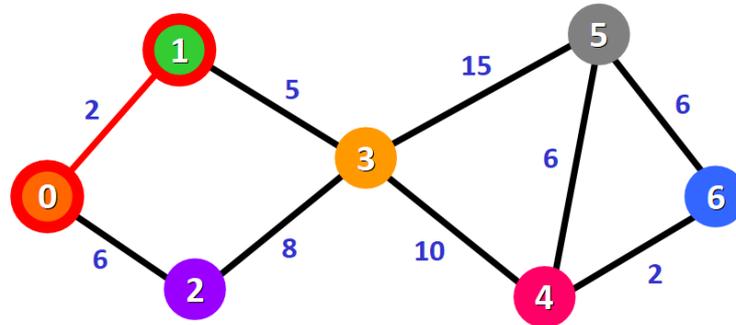
6: ∞

We cross it off from the list of unvisited nodes:

Unvisited nodes = {~~0~~,1,2,3,4,5,6}

Now we need to analyze the new adjacent nodes to find the shortest path to reach them. We will only analyze the nodes that are adjacent to the nodes that are already part of the shortest path (the path marked with red edges).

Node 3 and node 2 are both adjacent to nodes that are already in the path because they are directly connected to node 1 and node 0, respectively, as you can see below. These are the nodes that we will analyze in the next step.



Since we already have the distance from the source node to node 2 written down in our list, we don't need to update the distance this time. We only need to update the distance from the source node to the new adjacent node (node 3):

Distance:

0: 0
 1: ∞ 2 ok
 2: ∞ 6
 3: ∞ 7
 4: ∞
 5: ∞
 6: ∞

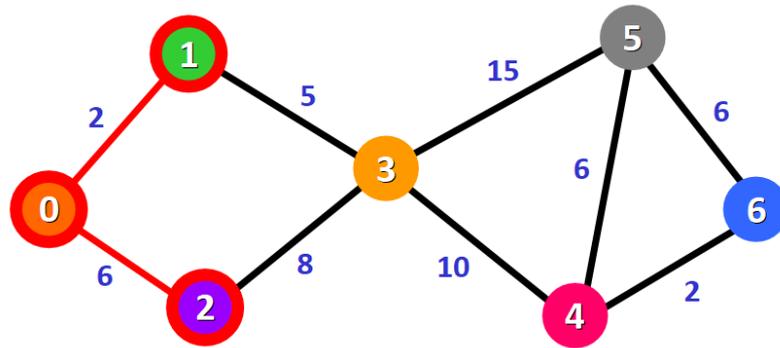
This distance is 7. Let's see why.

To find the distance from the source node to another node (in this case, node 3), we add the weights of all the edges that form the shortest path to reach that node:

- For node 3: the total distance is 7 because we add the weights of the edges that form the path 0 → 1 → 3 (2 for the edge 0 → 1 and 5 for the edge 1 → 3).

Now that we have the distance to the adjacent nodes, we have to choose which node will be added to the path. We must select the unvisited node with the shortest (currently known) distance to the source node.

From the list of distances, we can immediately detect that this is node 2 with distance 6. We add it to the path graphically with a red border around the node and a red edge:



We also mark it as visited by adding a small red square in the list of distances and crossing it off from the list of unvisited nodes:

Distance:

0: 0

1: ∞ 2 ok

2: ∞ 6 ok

3: ∞ 7

4: ∞

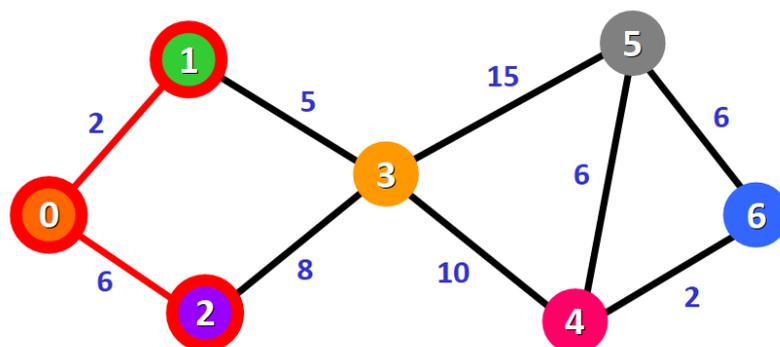
5: ∞

6: ∞

Unvisited nodes = {~~0~~,1,2,3,4,5,6}

Now we need to repeat the process to find the shortest path from the source node to the new adjacent node, which is node 3.

You can see that we have two possible paths 0 -> 1 -> 3 or 0 -> 2 -> 3. Let's see how we can decide which one is the shortest path.



Node 3 already has a distance in the list that was recorded previously (7, see the list below). This distance was the result of a previous step, where we added the weights 5 and 2 of the two edges that we needed to cross to follow the path 0 -> 1 -> 3.

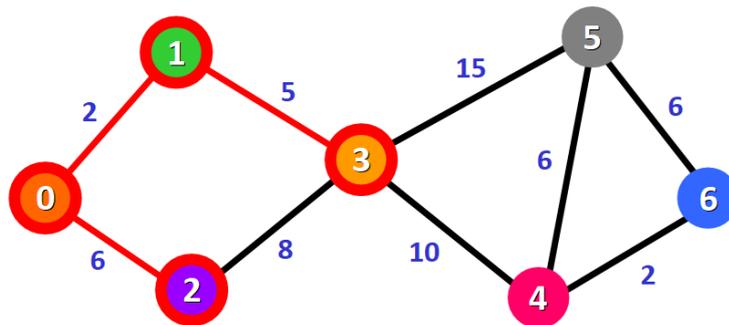
But now we have another alternative. If we choose to follow the path $0 \rightarrow 2 \rightarrow 3$, we would need to follow two edges $0 \rightarrow 2$ and $2 \rightarrow 3$ with weights 6 and 8, respectively, which represents a total distance of 14.

Distance:

0: 0
 1: ∞ 2 ok
 2: ∞ 6 ok
 3: ∞ 7 from (5+2) vs 14 from (6+8)
 4: ∞
 5: ∞
 6: ∞

Clearly, the first (existing) distance is shorter (7 vs. 14), so we will choose to keep the original path $0 \rightarrow 1 \rightarrow 3$. We only update the distance if the new path is shorter.

Therefore, we add this node to the path using the first alternative: $0 \rightarrow 1 \rightarrow 3$.



We mark this node as visited and cross it off from the list of unvisited nodes:

Distance:

0: 0
 1: ∞ 2 ok
 2: ∞ 6 ok
 3: ∞ 7 ok
 4: ∞
 5: ∞
 6: ∞

Unvisited nodes = {0,1,2,3,4,5,6}

Now we repeat the process again.

We need to check the new adjacent nodes that we have not visited so far. This time, these nodes are node 4 and node 5 since they are adjacent to node 3.

We update the distances of these nodes to the source node, always trying to find a shorter path, if possible:

- For node 4: the distance is 17 from the path 0 -> 1 -> 3 -> 4.
- For node 5: the distance is 22 from the path 0 -> 1 -> 3 -> 5.

 Tip: Notice that we can only consider extending the shortest path (marked in red). We cannot consider paths that will take us through edges that have not been added to the shortest path (for example, we cannot form a path that goes through the edge 2 -> 3).

Distance:

0: 0

1: ∞ 2 ok

2: ∞ 6 ok

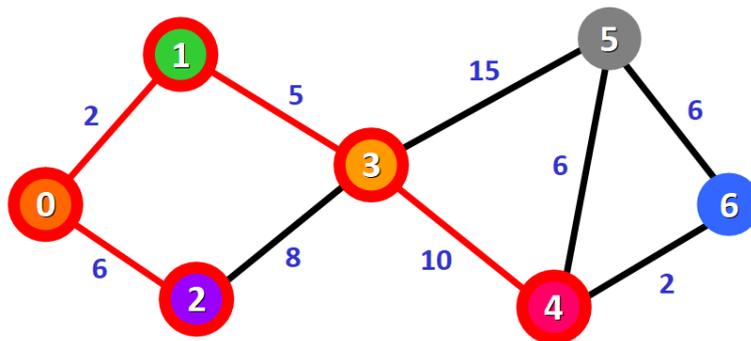
3: ∞ 7 ok

4: ∞ 17 from (2+5+10)

5: ∞ 22 from (2+5+15)

6: ∞

We need to choose which unvisited node will be marked as visited now. In this case, it's node 4 because it has the shortest distance in the list of distances. We add it graphically in the diagram:



We also mark it as "visited" by adding a small red square in the list:

Distance:

0: 0

1: ∞ 2 ok

2: ∞ 6 ok

3: ∞ 7 ok

4: ∞ 17 ok
 5: ∞ 22
 6: ∞

And we cross it off from the list of unvisited nodes:

Unvisited nodes = {~~0~~,1,2,3,4,5,6}

And we repeat the process again. We check the adjacent nodes: node 5 and node 6. We need to analyze each possible path that we can follow to reach them from nodes that have already been marked as visited and added to the path.

For node 5:

- The first option is to follow the path 0 -> 1 -> 3 -> 5, which has a distance of 22 from the source node (2 + 5 + 15). This distance was already recorded in the list of distances in a previous step.
- The second option would be to follow the path 0 -> 1 -> 3 -> 4 -> 5, which has a distance of 23 from the source node (2 + 5 + 10 + 6).

Clearly, the first path is shorter, so we choose it for node 5.

For node 6:

- The path available is 0 -> 1 -> 3 -> 4 -> 6, which has a distance of 19 from the source node (2 + 5 + 10 + 2).

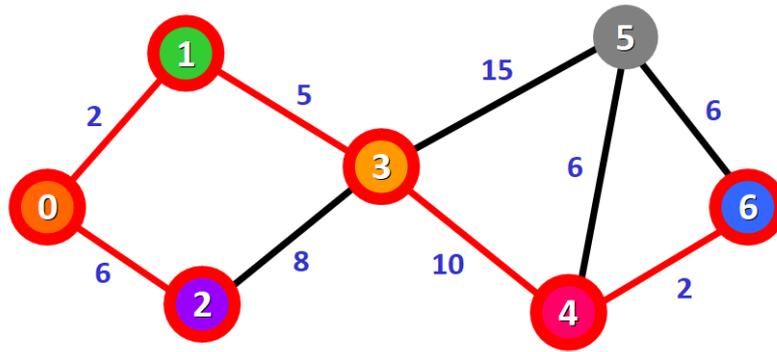
We mark the node with the shortest (currently known) distance as visited. In this case, node 6

Distance:
 0: 0
 1: ∞ 2 ok
 2: ∞ 6 ok
 3: ∞ 7 ok
 4: ∞ 17 ok
 5: ∞ 22
 6: ∞ 19 ok

And we cross it off from the list of unvisited nodes:

Unvisited nodes = {~~0~~,1,2,3,4,5,6}

Now we have this path (marked in red):



Only one node has not been visited yet, node 5. Let's see how we can include it in the path.

There are three different paths that we can take to reach node 5 from the nodes that have been added to the path:

- **Option 1:** 0 -> 1 -> 3 -> 5 with a distance of 22 (2 + 5 + 15).
- **Option 2:** 0 -> 1 -> 3 -> 4 -> 5 with a distance of 23 (2 + 5 + 10 + 6).
- **Option 3:** 0 -> 1 -> 3 -> 4 -> 6 -> 5 with a distance of 25 (2 + 5 + 10 + 2 + 6).

Distance:

0: 0

1: ∞ 2 ok

2: ∞ 6 ok

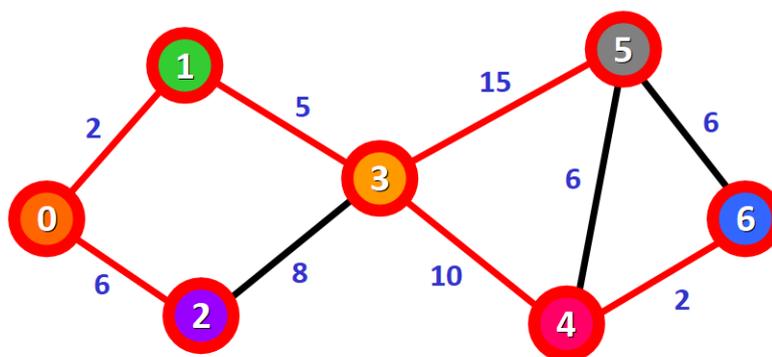
3: ∞ 7 ok

4: ∞ 17 ok

5: ∞ 22 22 from (2+5+15) vs 23 from (2+5+10+6) vs 25 from (2+5+10+2+6)

6: ∞ 19 ok

We select the shortest path: 0 -> 1 -> 3 -> 5 with a distance of 22.



We mark the node as visited and cross it off from the list of unvisited nodes:

Distance:

0:	0	
1:	∞	2 ok
2:	∞	6 ok
3:	∞	7 ok
4:	∞	17 ok
5:	∞	22 ok
6:	∞	19 ok

And we cross it off from the list of unvisited nodes:

Unvisited nodes = {~~0~~,~~1~~,~~2~~,~~3~~,~~4~~,~~5~~,~~6~~}

And voilà! We have the final result with the shortest path from node 0 to each node in the graph.

In the diagram, the red lines mark the edges that belong to the shortest path. You need to follow these edges to follow the shortest path to reach a given node in the graph starting from node 0.

For example, if you want to reach node 6 starting from node 0, you just need to follow the red edges and you will be following the shortest path 0 -> 1 -> 3 -> 4 -> 6 automatically.

Part III APPENDIX

1.1 RESEARCH SURVEY REPORT FROM GREECE AND ITALY

Final Report

Partners: LabSTEM (Greece), InProgress (Italy)

The main aim of the proposed questionnaire was the research the readiness and perception of adult teachers in Greece and Italy as far as the Algorithmic Thinking in intercultural education concerns. The survey took place between the period of 18.04.2022 and 06.06.2022.

1. Teachers' characteristics

In total, the questionnaire has been answered by 36 persons of whom 13 (36%) was males and 23 (64%) were females. The majority of the participants were between 36 and 55 years old (22% between 36-45 and 39% between 46-55 respectively), while the 8% between 25-35 and 31% over the 55.

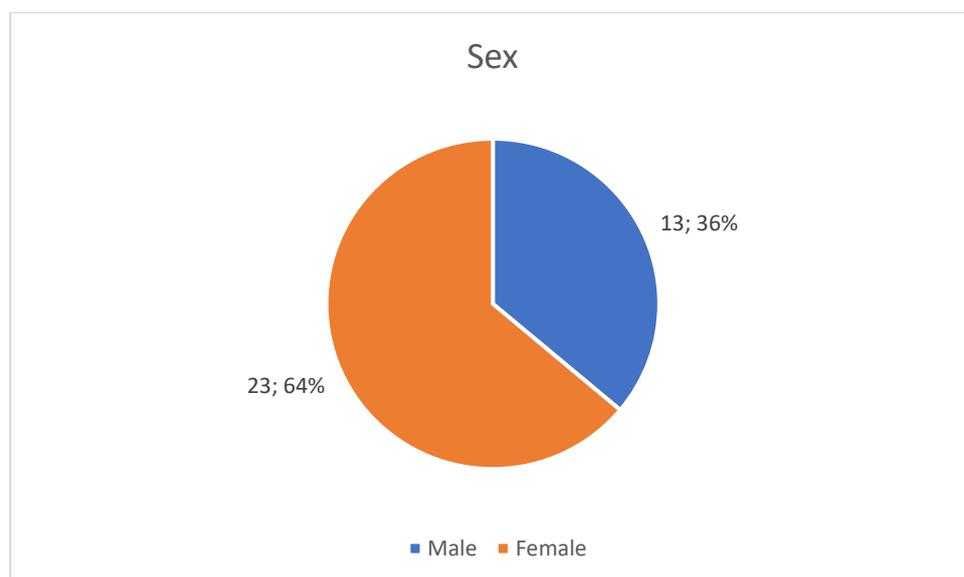


Figure 6 64% are female and 36% male

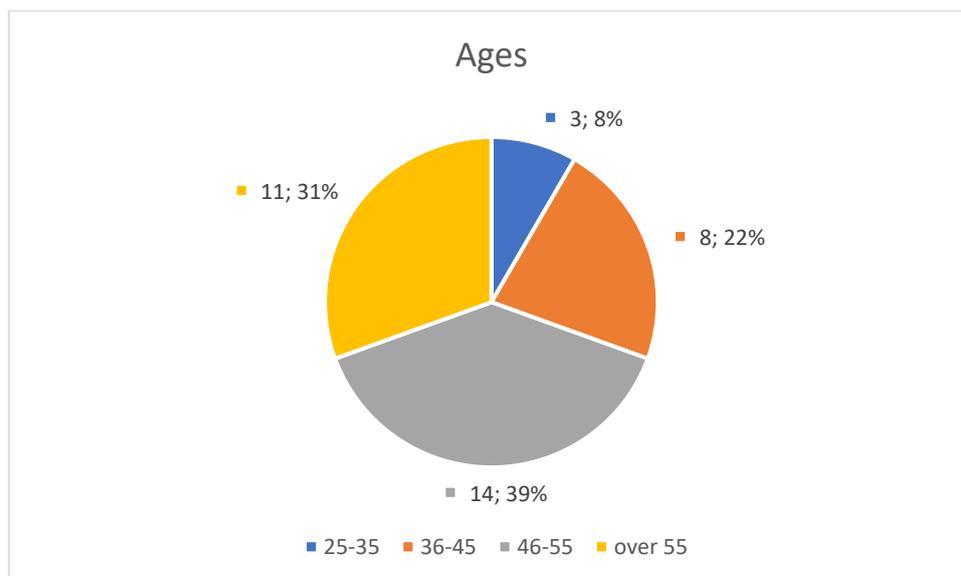


Figure 7 Ages diagram

The majority of the participants were teachers with more than 10 years of working experience. Greece and Italy are still very strict with new teachers hiring due to the previous economic crisis. Thus, 81% of them have more than 10 years of working experience while 11% less than 3 years and 8% between 4-9 years.

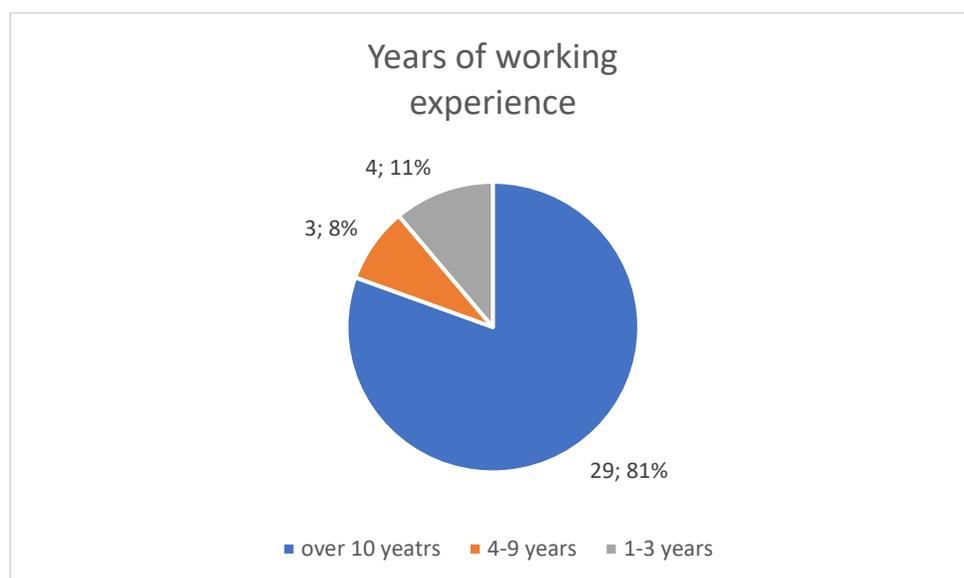


Figure 8 Years of working experience

Another important characteristic is that the 53% of them are teaching at Primary and Secondary Sector (19 teachers) while the 8% (3 teachers) at NGO structures and 39% (14 teachers) working at training centers.

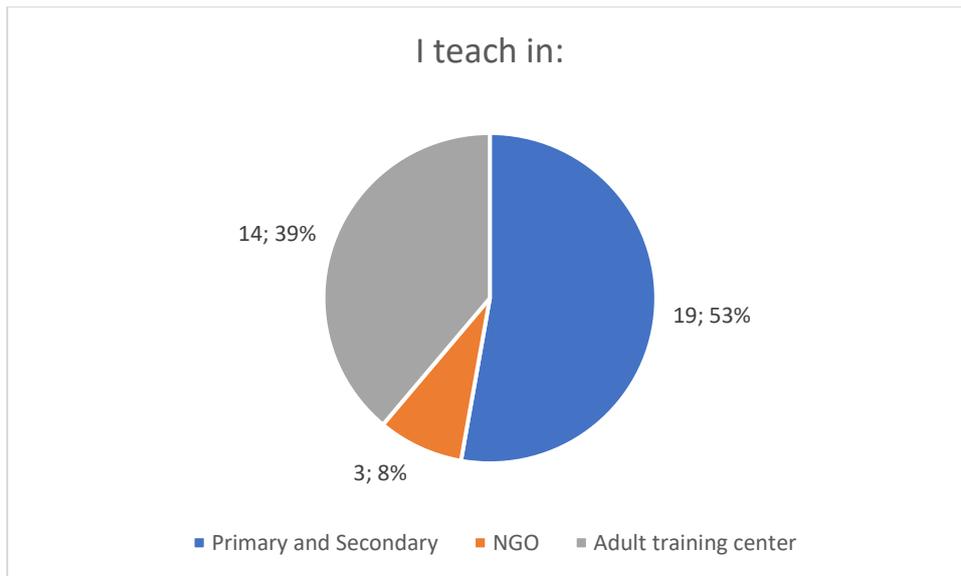


Figure 9 53% teach at Primary and Secondary Sector

Another characteristic is that most of the participants are STEM teachers (64%) while non-STEM teachers are the rest 36%.

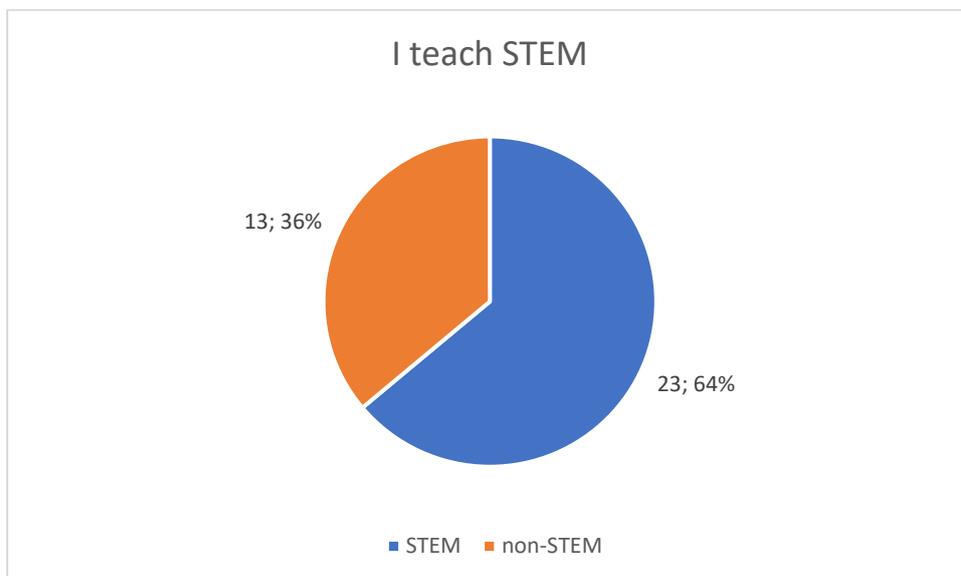


Figure 10 participants are equally divided to STEM and non-STEM teachers

2. Theoretical and practical knowledges

This part is related with teachers aware about the Algorithmic Thinking theoretically.

1.1	Problem-solving techniques	0%	29%	51%	20%
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1.2	Problem-solving skills and competence.	0%	29%	46%	26%
1.3	Algorithm meaning	26%	31%	6%	37%
1.4	Algorithm notation	29%	29%	9%	32%
1.5	Algorithmic Thinking	24%	35%	12%	29%
1.6	Practical aspects of building problem solutions in education.	15%	41%	18%	26%
1.7	Modern approach to Algorithmic Thinking.	30%	40%	15%	15%

The above table shows the percentages of each answer separately. As a whole picture, it seems that the majority have a good knowledge of how to solve problems but they don't know how to systematically depict or represent the solving procedure. They have no good knowledge of the meaning and importance of algorithms (questions 1.3, 1.4, 1.5, 1.6, 1.7). If we take into account that 64% of participants are STEM teachers, we easily understand that they definitely need support on the algorithmic topic and the way they can use it into the classroom.

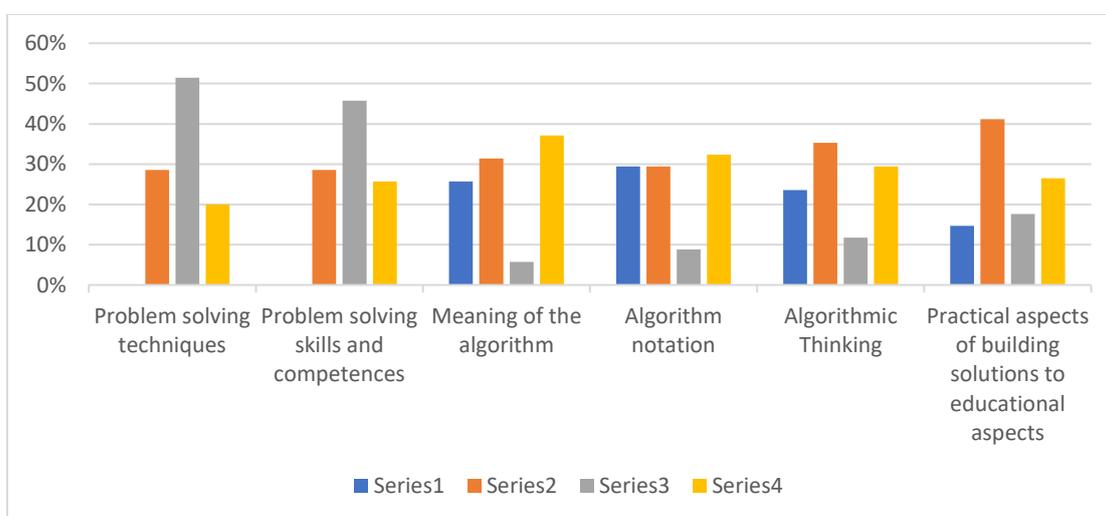


Figure 11 How prepared teachers are on algorithmic thinking topic

3. Algorithmic Thinking in Teacher Practice

This section is about the teacher's ability on how to perform activities about algorithmic thinking or problem-solving topic.

39% deem that to teach to students how to analyze problem requirements is easy enough, 17% that is difficult while the rest 44% is neutral.

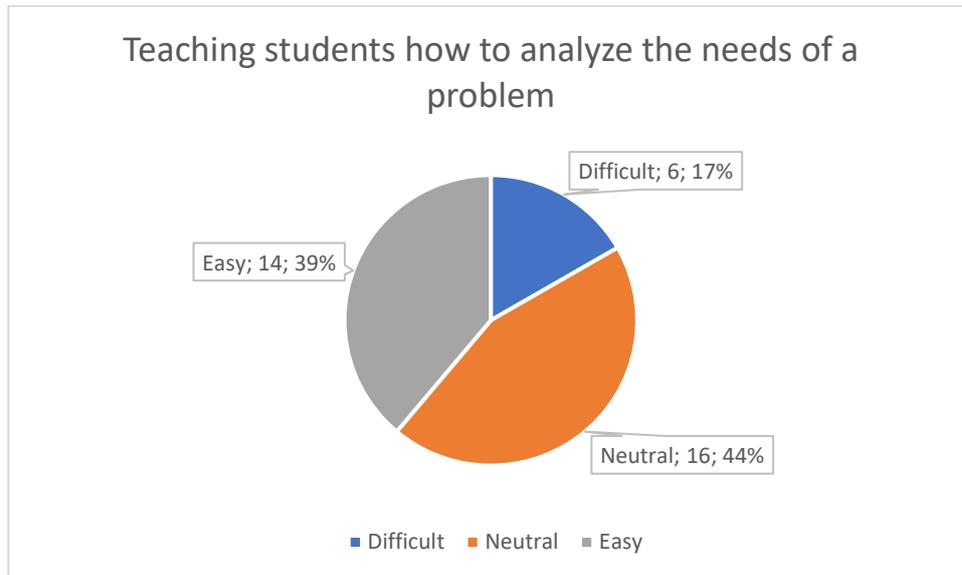
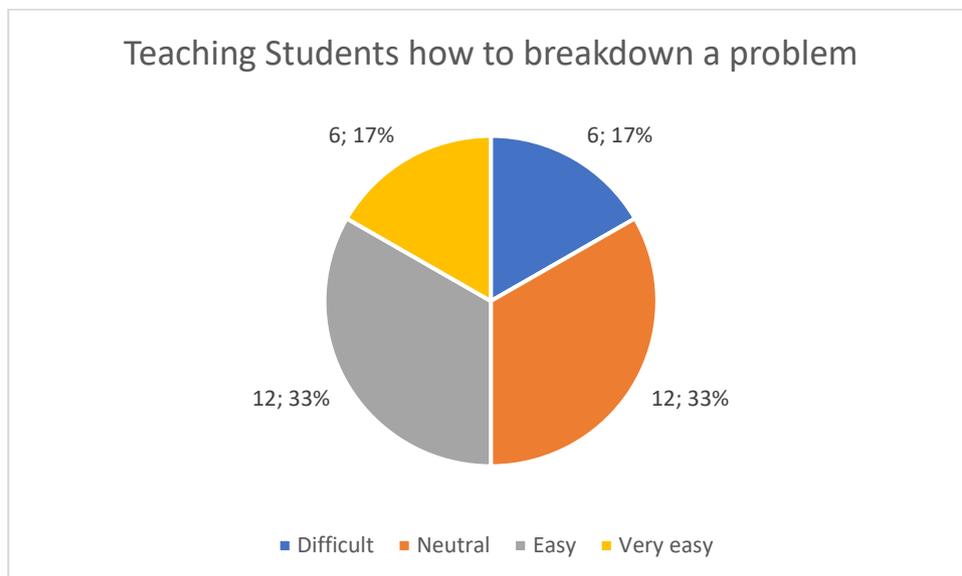
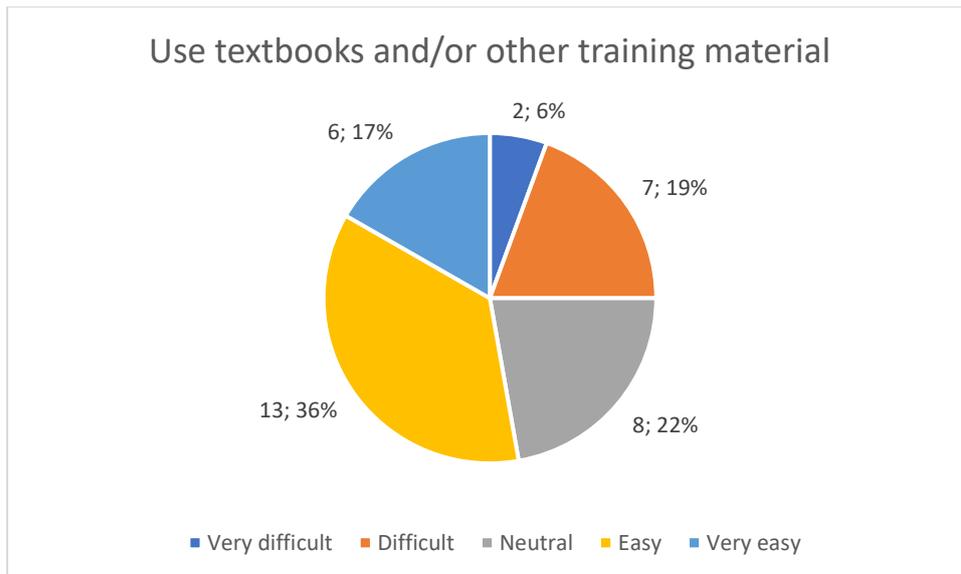


Figure 12 Analyze problem requirements

66% stated that to teach to students how to decompose a problem to smaller and easy understandable parts is neutral and easy (33%+33%) while the rest 34% (17% and 17%) is difficult and very easy respectively.



53% stated that is easy and very easy to use textbooks or/and other training material concerning the problem-solving topics, while 22% neutral and 19% that is difficult.



The 25% of participants absolutely understand what Algorithmic Thinking is and 19% quite enough. The rest 56% have no idea (or a little – which practically means nothing) of what is Algorithmic thinking.

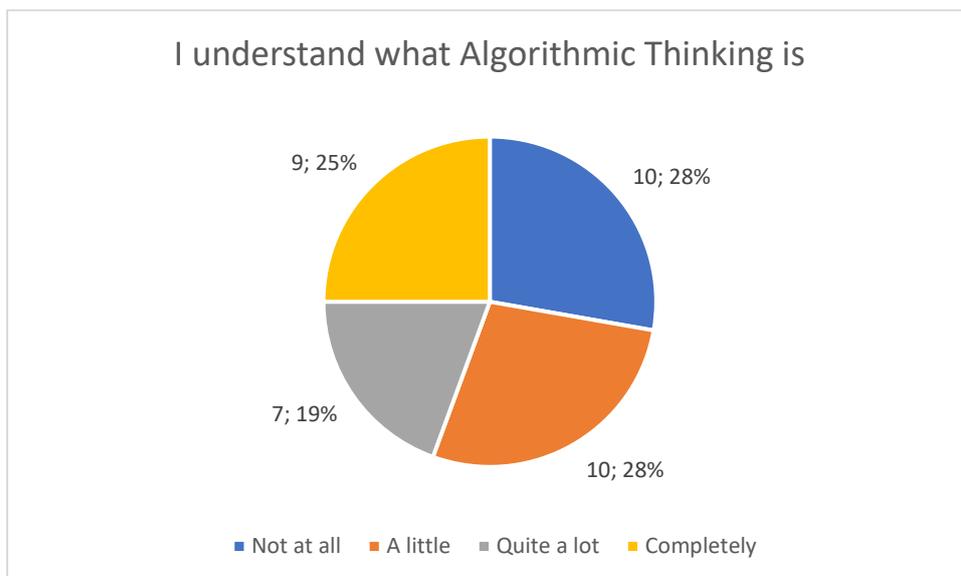
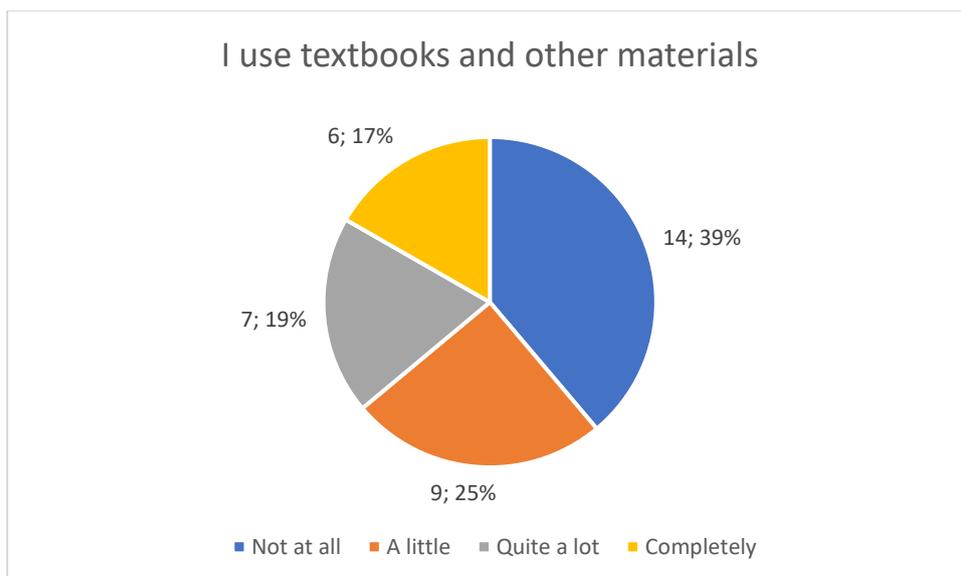


Figure 13 Who understands what Algorithmic Thinking is

The next question shows that the majority of the participants (39% + 25%) do not use textbooks and/or other material to support teaching algorithmic thinking in my classroom practice, while the rest 36% quite a lot and completely.



Next, the majority 67% believe that Algorithmic Thinking competence is a skill important for their professional development while the rest 33% they don't care.

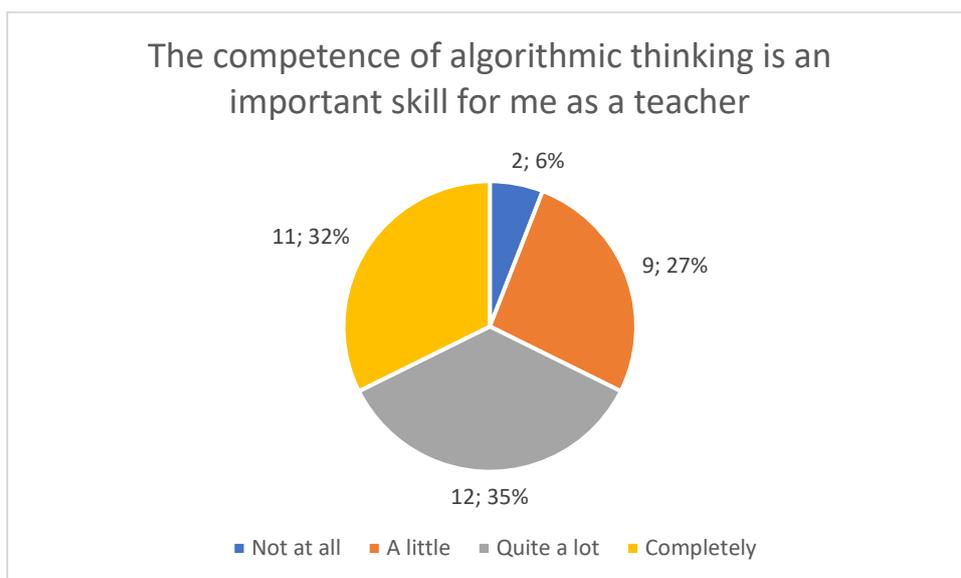
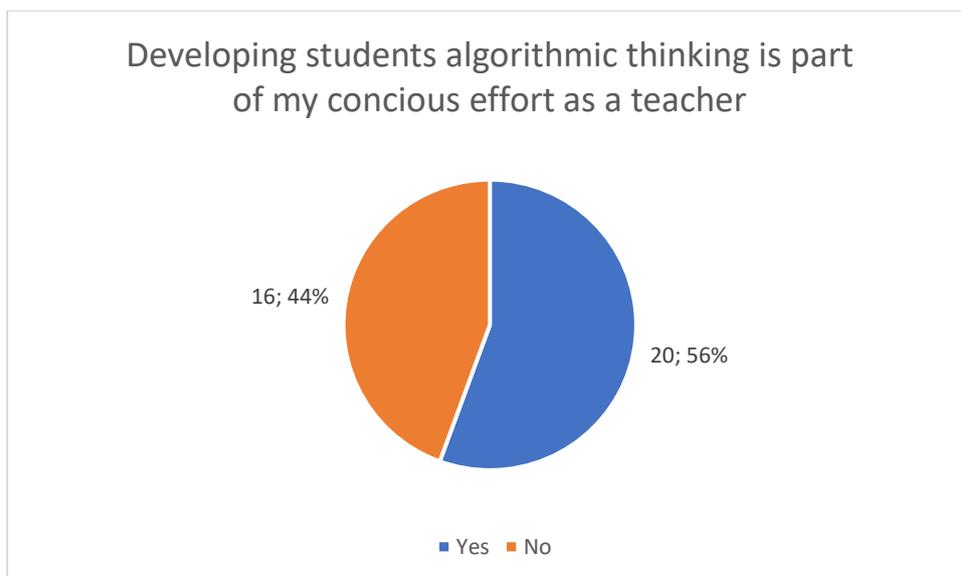


Figure 14 67% believe that Algorithmic Thinking competence is a skill important

The next question is quite interesting because it shows that despite 64% of them are STEM teachers the 56% of them believe that developing students' Algorithmic Thinking is a part of their conscious effort as a teacher.



As a continuation of the previous question, 58% stated that Algorithmic Thinking could sometimes help students to understand better the lessons taught by them while 36% always. This shows that the majority is not sure about the importance of Algorithmic Thinking.

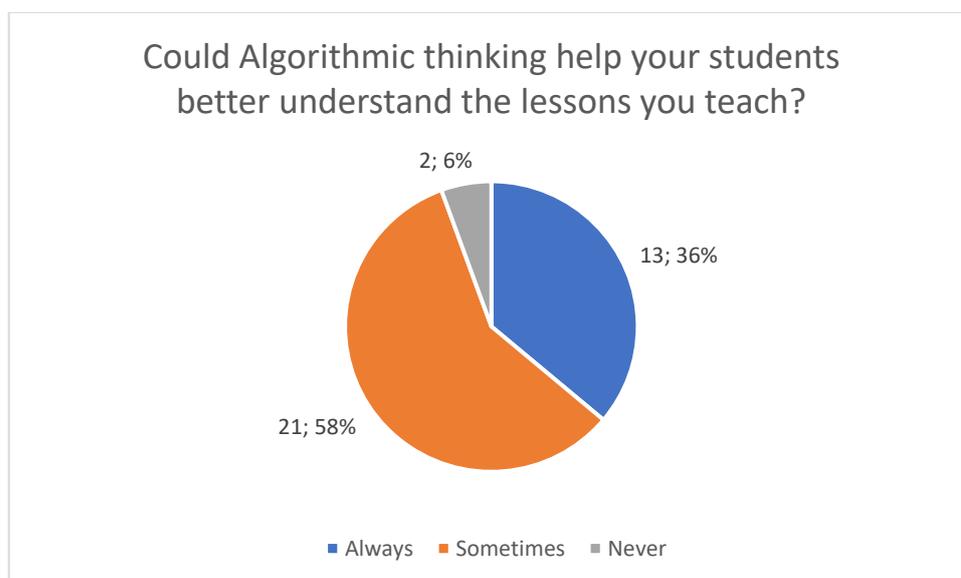
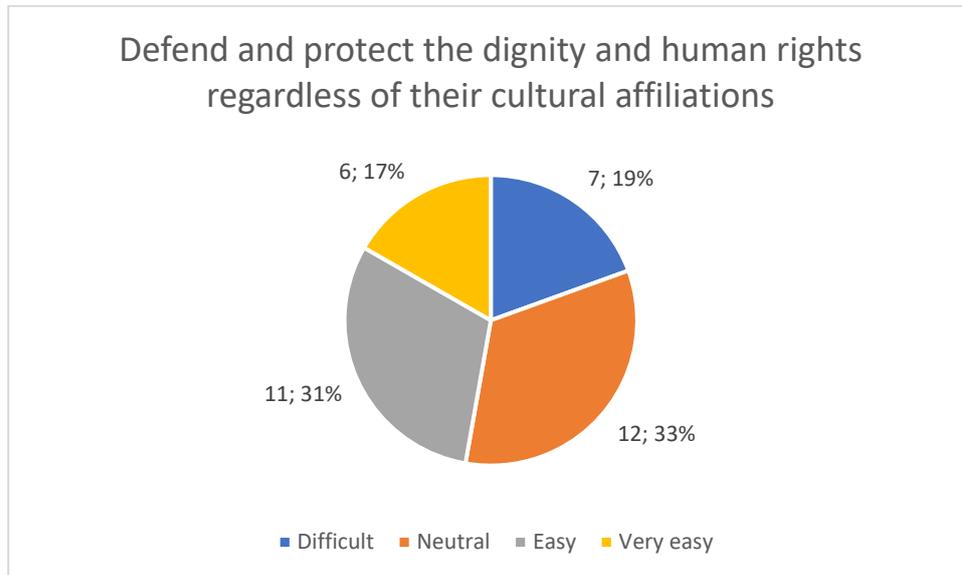


Figure 15 Algorithmic Thinking could sometimes help students to understand better the lessons taught by them

4. Intercultural Education

This section is about the teachers' intercultural skills.

48% of asked teachers replied that to defend and protect the dignity and human rights of people regardless of their cultural affiliations is easy and very easy, while the rest 52% is neutral and difficult.



Teachers stated that know and respect the cultural values and religious beliefs of others cultures.

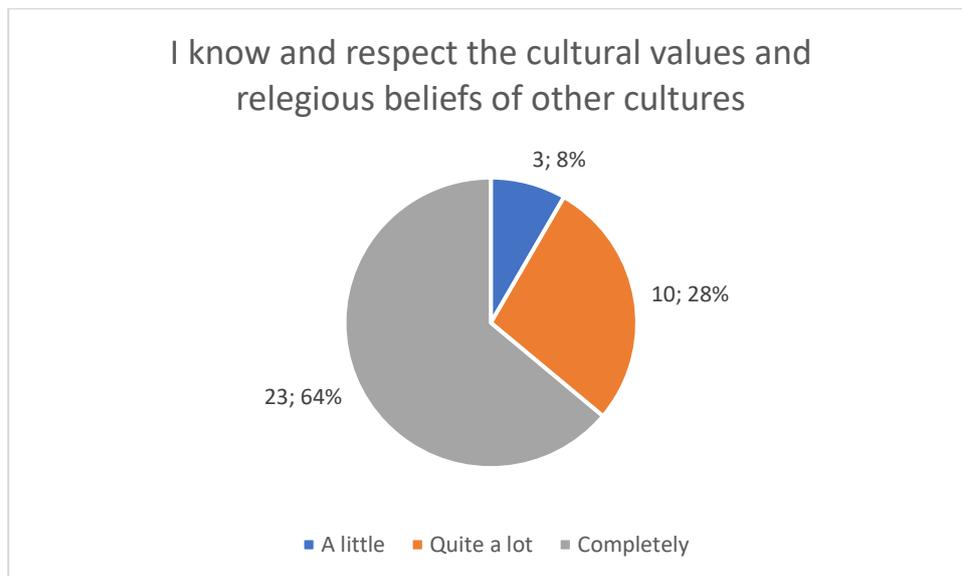


Figure 16 know and respect the cultural values and religious beliefs of others cultures.

The majority of 66% feel confident when interacting with people from different cultures while the rest 34% a little.

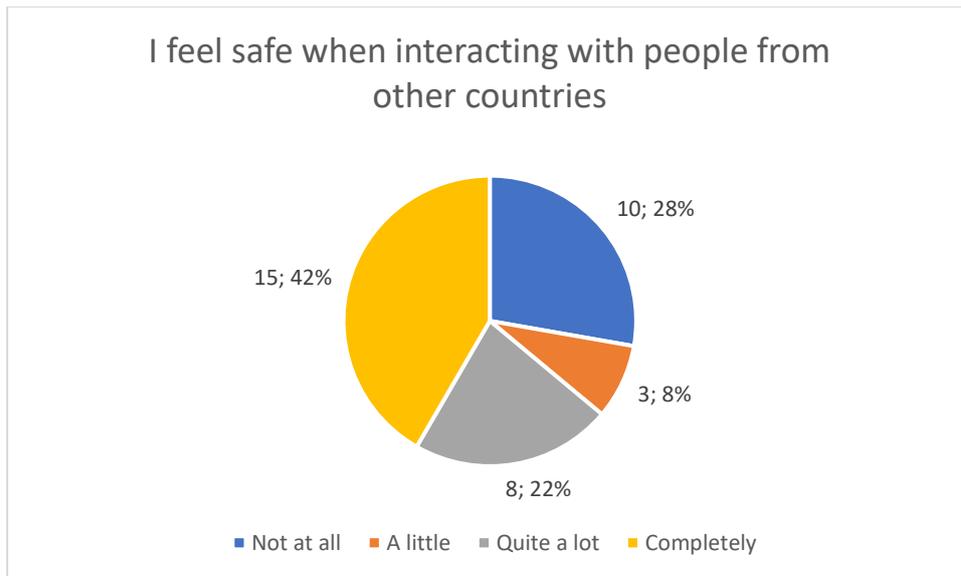


Figure 17 The majority of 66% feel confident when interacting with people from different cultures

31% believe that the knowledge about different cultures and the importance of intercultural communication is provided sufficiently in schools/training centers, while the rest 69% don't

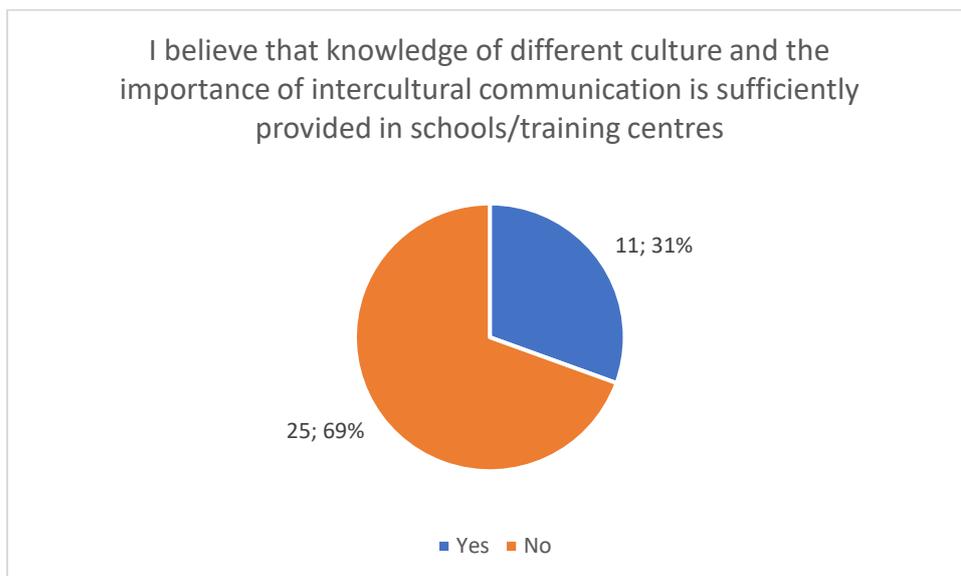


Figure 18 31% believe that the knowledge about different cultures and the importance of intercultural communication is provided sufficiently in schools/training centers

Comments

- One stated that Algorithm is an international language that could join all people!
- I found the wording of the questions unclear
- I don't know algorithmic thinking

Conclusions

The main aim of this survey was to find out if and to what extent adult trainers incorporate the Algorithmic Thinking principles and guidelines in their learning material design and teaching. We found out that STEM teachers are more familiar with the field of algorithmic thinking while non-STEM teachers ask for specific training. They have no idea of what and how they can apply algorithmic thinking in the classroom, thus trainees with different cultures (intercultural education) are not educated in this field. As a consequence, they have difficulties in the labour market and their social incorporation.

We definitely have to take into account all the above findings and design a Handbook that will help adult immigrants/refuges trainers to utilize Algorithmic Thinking principles in their teaching procedure and subsequently transmit their knowledge to trainees.

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