

Hallå STEAM: Building Bridges Between Mathematics, Arts, and Humanities

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Abstract

We present an on-going project in Finland called Hallå STEAM which aims to build bridges between mathematics, arts, and humanities in the form of various school activities, including workshops, drama pedagogy, and guest lectures. A special feature is the use of Swedish language, the minority official language of Finland, which remains an important part of the Finnish National Core Curriculum.

Background

Finland has two official languages: Finnish and Swedish. Finland having been an integral part of the Swedish Kingdom for many centuries (from the 12th century until 1809), Swedish used to be the dominant language of culture well until the late 19th century whereas nowadays Finnish dominates in all fields of life. A vast majority (87.6 %) of Finland's citizens speak Finnish as their mother tongue whereas the Swedish-speaking minority has declined to 5.2 %. Even so, several municipalities – especially on the coastline and in the entire archipelago of Åland between Finland and Sweden – remain fully Swedish-speaking, and the Swedish-speaking institutions (many schools and one university; many parishes and one diocese; an army unit; a political party; learned societies and cultural foundations; newspapers and other media outlets, etc.) have maintained a high status. It is an essential part of Finland's national language policy to maintain and support the vitality of Swedish despite the dwindling numbers of its speakers. Thus, every citizen is supposed to learn both national languages at school, and a working knowledge of both is required for many public positions, including academic jobs. Nevertheless, there are large areas of Finland where Swedish has little presence in daily life, and its knowledge remains, generally speaking, poor.

To improve the situation, the Swedish Cultural Foundation of Finland (*Svenska kulturfonden*) has launched many initiatives over the years. Among the many, there is an ongoing one called “Hallå STEAM” which the present authors initiated in 2018. STEAM is the familiar acronym for ‘Science, Technology, Engineering, Art, and Mathematics’ whereas ‘Hallå’ is the Swedish equivalent for ‘Hello’. Of the two authors, Dr. Pekonen's mother tongue is Finnish whereas Dr. Stén is a Swedish-speaking Finn, but both are fluent in both national languages. Besides ourselves, two Hungarian-born partners are involved: Dr. Kristóf Fenyvesi and Nóra Somlyódy; they are the founders of an international pedagogical network called Experience Workshop (www.experienceworkshop.org) which aims to revitalize school teaching of mathematics with the help of a large variety of games, toys, puzzles, workshop kits, and other learning tools and methods. In the framework of this scheme, our team has made numerous visits to mainly Finnish-speaking schools all over Finland presenting interdisciplinary lessons that in various ways combine creative and artistic mathematical problem-solving with elements of Swedish language and culture.

A Variety of Approaches and Aims

The simplest way of combining mathematics and Swedish is to go and deliver a mathematical lecture in Swedish, but making a creative connection between these subjects can help to motivate and engage

students better. We have sometimes applied live-action role playing where a historical approach has appeared promising, given that Swedish language is often associated with Finland's past. Many of our topics with a historical bent have had to do with the 17th or the 18th century because those were the times of greatest Swedish prominence around the Baltic Sea. For instance, Dr. Stén has sometimes assumed the role of the 18th century Finnish mathematician and astronomer Anders Johan Lexell (1740–1784) whose life and work he has extensively studied ([1, 2]). Lexell was an assistant – and finally also the successor – of Leonhard Euler (1707–1783) in the Imperial Academy of Saint Petersburg. Many others of Finland's great scientists have been Swedish-speaking, for instance, our only Fields medallist, Lars Ahlfors (1907–1996).

Sometimes, visiting a new locality, we have thoroughly thought about local cultural heritage and tried to offer a program which ties up with a Swedish-speaking figure who has special significance in the region; this could be equally well a scientist, a poet, or a soccer star. Indeed, as a motivation, figures of pop culture, and other youth idols, may work better than scientists – if you can find any chain of associations leading to mathematics. A special success was the lecture where Dr. Pekonen started from Tim Sparv, the Swedish-speaking captain of the Finnish national soccer team, then proceeded to study the classical black-and-white soccerball which much resembles to a truncated icosahedron. The students were given the task to create physical models of the truncated icosahedron (buckyball, buckminsterfullerene). In a heuristic collaborative problem-solving process, they were led to discover the Euler formula $V - E + F = 2$ for the vertices (V), edges (E) and faces (F) of a general polyhedron. For similar purposes, Dr. Stén has co-authored a paper in Swedish [3] about the presence of astronomy in the beloved Moomin children's book series created by the Swedish-speaking Finnish author Tove Jansson (1914–2001). Lectures on sophisticated topics in Swedish, however, work best only in senior high school (*lukio* in Finnish, *gymnasium* in Swedish) corresponding typically to ages from 17 to 19.

As for younger age groups, we have organized activities also for kids who only begin their studies of Swedish (which happens typically at age 12), then resorting to playing rather than lecturing. By implementing mathematical toolkits of the Experience Workshop, we have created partially, or wholly, Swedish-speaking math-art workshops making use of numerous different mathematical-artistic games, experiments, and learning tools. The results have been promising: a playful approach seems to help to blur the boundaries between math and Swedish, two school subjects with a difficult reputation. Focusing on a mathematical-artistic hands-on project, the students have learned some Swedish almost without noticing or, at least, have realized that they do understand more Swedish than they expected. For some students living in the non-Swedish-speaking regions of the country, participation in our program may have been, indeed, their first encounter with Swedish in a “real-life” situation. Everything that we do aims to be interactive, even if creating verbal interaction is always a challenge when dealing with young people with limited skills in a language which is not their mother tongue.

Hallå STEAM corresponds well to the pedagogical ends of the STEAM integrated curriculum movement. Indeed, a certain amount of transdisciplinary and phenomenon-based teaching is required in the present Finnish National Curriculum for Basic Education but the schools enjoy a great autonomy in choosing the themes and creating the contents. Integrating mathematics with other school subjects – especially with arts and humanities – is not so obvious but our task group has sometimes invested a lot of effort to create interesting mathematical-artistic contents for the few hours that have been allocated to us as external visitors. Our offer to provide an unusual school day may have appeared attractive to some teachers because it sometimes has solved for them the challenging problem of creating a phenomenon-based lesson on mathematics and hopefully served to inspire further STEAM activities along similar lines. Investing all of our skills, we have sometimes presented an even more artistic program, performed songs or poems in Swedish, or created a small-scale play applying drama pedagogy.

Some Examples

In the following, we present three examples of school visits that appeared particularly successful to us.



Figure 1: *Teaching ballistics in fake military uniforms. Dr. Stén on the left, Dr. Pekonen on the right.*

On the 6th of November 2018, we visited the Keljonkangas school in Jyväskylä, a university town in Central Finland. The date has special significance in Sweden, and also in Finland – where it is celebrated as the Swedish Day – because it is the date of the death of Gustavus Adolphus, King of Sweden, in the battle of Lützen in 1632 in the Thirty Years’ War. Dressed in ancient-looking costumes, complete to boots, hats and swords, we reenacted scenes from the battle. Osmo Pekonen’s role figure was Count Carl Gustaf Wrangel (1613–1676), an innovative Swedish military commander, whereas Johan Stén played the role of Count Johan af Sténstierna, an imaginary military engineer and brilliant mathematician. During the play, we deduced on blackboard – interacting with each other and with the class in Swedish – the basic formulas of ballistics describing the parabolic shape of the trajectory of a projectile. In real life, the problem was first solved by Galileo in 1638, i.e., during the Thirty Year’s War. The pupils were duly impressed by our costumes and swords, as well as by a 17th century military march in Swedish that concluded the lesson.

In a more peaceful mode, on the 14th of January 2019 in the Hollihaka school in Kokkola (in Swedish: Karleby), a bilingual town on the West Coast of Finland, we discussed the extraordinary life of a local hero, the explorer and adventurer Henrik Jakob Wikar who was born in Kokkola in 1752. He joined the Dutch East India Company and traveled to the Cape of Good Hope, then deserted the Company and went into hiding for years in the wilderness among the natives. His journal [4] is a pioneering description of the South African indigenous people, the Khoi and the San. The two of us gave lectures in Swedish on Wikar’s adventures. A mathematical aspect was introduced in the form of an ethnomathematical study of the geometric patterns in the traditional handicrafts of the Ndebele, another indigenous people of South Africa, whose art one of us, Dr. Kristóf Fenyvesi, has studied on site. The students were asked to construct a creative model of a Ndebele village, decorating the individually designed huts with various symmetric patterns and other geometrical ornamentation inspired by authentic documentation of Ndebele heritage. Given the historical link between Kokkola and South Africa, this school project is planned to lead to exchanges between the Hollihaka school and schools in South Africa.

In the beginning of November 2019, during the so-called “Swedish Week”, we made a grand tour of Lapland visiting several schools in Tornio and Kemi, and a teachers’ training college in Rovaniemi, the capital of Finnish Lapland. Our general theme was the 18th century geodetic expedition of the French Royal Academy of Sciences which stayed over the winter 1736–1737 in the Tornio river valley to measure the precise shape of the Earth. The expedition succeeded, under the charismatic leadership of the mathematician Pierre Louis Moreau de Maupertuis (1698–1759), to demonstrate that our planet is not a

perfect sphere but slightly flattened (like a mandarin orange) at its poles due to its rotational movement [5]. A Swedish participant was Anders Celsius (1701–1744), professor of astronomy at the Uppsala University. There exists a movie *La figure de la Terre* about the expedition where Dr. Pekonen plays the role of Maupertuis whereas Dr. Stén is Celsius [6]. Screening the movie and, indeed, playing the roles of its lead characters in the classroom, once again in historical costumes, we managed to explain – in Swedish – some mathematical aspects of geodesy and astronomy, not forgetting the new temperature scale developed by Celsius.



Figure 2: *Drama pedagogy in a school in Tornio, Lapland. Dr. Pekonen plays the role of the mathematician Pierre Louis Moreau de Maupertuis; Dr. Stén is the astronomer Anders Celsius.*

Summary and Conclusions

The Hallå STEAM project goes on, and it has developed a nationwide reputation. Indeed, our team has visited schools in Finland from the South Coast to the Arctic Circle. Ever new themes in the interface of art, history, culture, and mathematics are being brought up and discussed, always with a Swedish twist. We are indeed experiencing ourselves what we profess to our youthful audiences: learning by doing. We also collect feedback, mainly from the teachers. In the future, it will be interesting to evaluate what we have achieved as constructors of bridges between mathematics, arts, and humanities.

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