

A Study on University Education of Medieval European Mathematicians

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Abstract

Higher educational institutions in a country play an important role in the cultural transformation of people. Its role in the coordination and strengthening of new knowledge and its proper dissemination in the community is an important factor in the development of any country. In this paper we compare the importance of role played by higher educational institutions in the development of Kerala School of Mathematics and European School of Mathematics.

Key Words: Kerala school of mathematics, european school of mathematics, institutions of higher learning.

1. Introduction

The word university is originated from the Latin word “Universitas”, means the whole, the world or the universe. Before Universities were established, the main centers for education were monastic schools. Because of the increasing necessity for acquisition of knowledge, there happened the migration of cathedral schools to large cities. At the early stage Universities were consisted of a group of individuals assembled at some available spaces such as church or homes. Gradually Universities were established in secluded buildings and teachers were granted remuneration [1].

This paper deals with a cursory overview on the education details of eminent European scholars who made significant contributions in mathematics and other fields of interest during the period from 1300 to 1700. Following are some available information about the learning activities of the European mathematicians, that took place in the above mentioned period.

2. University Education of European Mathematicians

Richard of Wallingford (1292-1336) was an English mathematician, spent 15 years for education at Oxford University. He had studied, taught and made important contributions to mathematics and constructed astronomical instruments during his years at Oxford University [2]. Thomas Bradwardine (1295-1349) was one of the precocious student of Balliol College, Oxford University and in 1321 he became a fellow there. He acquired the degree of doctor of divinity and came to have the reputation of an outstanding and skillful mathematician and a theologian. He composed several works on Mathematics, logic and philosophy during 1300, while he was at Oxford University. Another scholar, Simon Bredon, who showed an interest in the field of medicine, was a Doctor of Medicine of the University of Oxford. He made many achievements in the sphere of natural science and astronomy while he was at Oxford University. He was also an astronomer and mathematician and was a mathematics tutor at the University. He wrote many works related to trigonometry, arithmetic and astronomy [3]. Johannes Muller (1436-1476) also named as Regiomontanus was a German mathematician and astronomer, had enrolled as a student in the University of Leipzig. He continued his studies at the University in Vienna, Austria. There he made friendship with his tutor and mathematician Georg von Peurbach. He was awarded his M. A. in 1457 [4]. Nicholas Copernicus (1473-1543) was famous as an astronomer but he was a trigonometer also. He had studied Islamic works on astronomy and geometry at the University of Bologna [5].

Michael Stifel (1487-1567) a German mathematician enrolled in the University of Wittenberg and studied mathematics under the instruction of the Jacob Milich, a mathematician, physician and astronomer lived in Germany during 1501 to

1559 and also he was awarded his M. A. degree from the University of Wittenberg. Next was a German scholar, Peter Apianus (1495-1552), who had studied Mathematics and Astronomy at the University of Leipzig and then entered the University of Vienna in 1516, continued his studies. In 1521, he obtained his bachelor's degree [6]. Christoph Rudolff (1499-1545) was studied at University of Vienna and he studied mathematics there under the guidance of Henricus Grammateus from 1517 to 1521, and also he wrote a book on algebra [7].

Erasmus Reinhold (1511-1553), a German astronomer and mathematician was considered to be an influential astronomical teacher of his generation [8]. Erasmus Reinhold studied mathematics at the University of Wittenburg and was appointed there as professor of higher mathematics. Franciscus Barocius was born to a wealthy family and he lived during 1537 to 1604. He learnt Greek and Latin in school at Padua, and then he studied mathematics at the University of Padua. Christoph Clavius (1538-1612) was a German mathematician who attended the University of Coimbra in Portugal, where he selected normal university curriculum and higher mathematics. Then he went to Rome in 1560 and studied theology at the Jesuit Collegio Romano, Gregorian University [4]. The Italian mathematician Guidobaldo Marchese del Monte (1545-1607) studied mathematics at the university of Padua in 1564 [9].

Michael Mastlin (1550-1631) was a mathematician and astronomer from German. He had studied theology, mathematics, and astronomy at the University of Tübingen. He graduated in 1571 and continued his studies there. In 1580 he joined University of Heidelberg as a professor of mathematics, and in 1583 he moved to the University of Tübingen, where he taught for 47 years [10]. Luca Valerio (1552-1618) was born in Naples. He had been studied at the Collegio Romano in Rome, Gregorian University and he was interested in philosophy and theology but he loved mathematics more [4]. At Collegio Romano, Clavius was his mathematics teacher [9].

Nathaniel Torporley (1564-1632), an English Scholar acquired mathematical and astronomical knowledge from Thomas Harriot when he was studying at Christ Church, Oxford University, and graduated B. A. in 1584 and M. A. from Brasenose College, Oxford University in 1591 [11].

Galileo Galilei (1564-1642) was an Italian scholar whose father Vincenzo Galilei was a music teacher. He was matriculated and studied medicine, mathematics and natural philosophy at the University of Pisa. Giuseppe Biancani (1566-1624) was an Italian scholar, studied mathematics under the famous Christopher Clavius at the Jesuit Collegio Romano, Gregorian University [11]. Francois d'Aguilon (1567-1617), a native of Belgium studied mathematics and philosophy from Donai University in 1588 and obtained M. A. in 1590 [4]. Paul Guldin (1577-1643) was a Swiss mathematician. Because of his talent and interest in mathematics his parents sent him to the Jesuit Collegio Romano in Rome, Gregorian University for studying mathematics under Clavius who was

a professor there [4]. Frans van Schooten Senior studied mathematics under Ludolph van Ceulen at the Engineering School in Leiden [4]. An Italian Jesuit priest, Orazio Grassi (1583-1654) was a well-known mathematician, astronomer and architect. He had studied mathematics, philosophy and theology at Roman College, Gregorian University [11].

A Flemish mathematician, Gregorie Saint – Vincent (1584-1667), was greatly inspired by Clavius to study mathematics, philosophy and theology. Clavius taught mathematics to Gregoire de Saint-Vincent at the Collegio Romano in Rome, Gregorian University and was one of his talented student. Albert Girard (1595-1632) was a French native mathematician who gave an inductive definition for Fibonacci numbers. When he was 22 years old, he joined the University of Leiden and studied mathematics there. Rene Descartes was born in 1596 in France. In 1629 he joined the University of Franekar for his studies and in 1630 he was matriculated at the Leiden University to study mathematics and astronomy. Descartes had made many contributions in the field of philosophy and analytical geometry and so he was considered as the father of modern philosophy and analytical geometry [12]. In 1612 Jacobus Golius (jacob Gool) (1596-1667) joined for studying mathematics at the university of Leiden. Henry Gellibrand (1597-1637) was introduced to mathematics by an English mathematician Sir. Henry Savile, at Trinity College, Oxford University on 22 March 1616. In 1619 he received a B. A. and in 1623 an M. A. from Trinity College. Bonaventura Francesco Cavalieri (1598-1647) was an Italian mathematician. At the University of Pisa, he was taught by the mathematics lecturer Benedetto Castelli [4].

Pierre de Fermat (1601-1665) was born into a wealthy family. After receiving the bachelor's degree in civil law in 1626 from the University of Orléans, he moved to Bardeaux, and started his mathematical research at the University of Bordeaux. William Brouncker, (1620 – 5 April 1684) was an English mathematician and the first President of the Royal Society. Brouncker at the age of sixteen years, entered Oxford University and there he studied many subjects including mathematics [4].

The scholar who flourished during the period 1622-1685, Rene-Francois Walter de Sluze, was matriculated at the University of Leuven. From the University of Rome, La Sapienza, he received his master's degree in law in 1643 and acquired knowledge in several languages, mathematics and astronomy from there [11]. Jan de Witt (1625-1672) was a Dutch scholar, who had studied mathematics at the University of Leiden. He got doctorate from the University of Angers in 1645. Erasmus Bartholin (1625-1698) was a Denmark native, received a B. A. degree in 1644 and an M. A. degree from the University of Copenhagen. He entered the University of Leiden in 1645 and studied mathematics there. In 1654, from the University of Padua, he received a medical degree [6].

Pietro Mengoli (1626-1686) was an Italian mathematician. He studied mathematics at Bologna University. He received degrees in philosophy in 1650

and in civil and canon law in 1653 [9]. Johannes Hudde (1628-1702) was an Amsterdam scholar who studied law and mathematics at the University of Leiden [4]. The Netherland mathematician Christiaan Huygens (1629-1695), was the son of Constantin Huygens. Huygens was sent to the University of Leiden, for studying law and mathematics. He had studied there from May 1645 to March 1647 [6]. Isaac Barrow (1630-1677), a foremost mathematician of the period made several contributions in calculus. He studied at Trinity College, Cambridge and received an M. A. in 1652 [13]. During the days at Trinity College, he showed his excellence in mathematics [6]. Robert Hooke (1635-1703) was an English mathematician, studied at Wadham College, Oxford University, where he was encouraged by Dr John Wilkins in astronomy, mathematics, and mechanics [14]. William Neile (1637-1670) was born as the eldest son of sir Paul Neile. William Neile had matriculated in 1655 at Wadham College, Oxford, where he was taught mathematics by John Wilkins and Seth Ward [15]. Gottfried Wilhelm Leibniz (1646-1716) was a German scholar. He was educated at University of Leipzig and studied mathematics and philosophy there. Also he got a bachelors degree in 1663. Ehrenfried Walther von Tschirnhaus was born in Kieslings Walde in Germany and lived during 1651 to 1708. He had studied mathematics, philosophy, and medicine at the University of Leiden [16].

Jacob Bernoulli was enrolled in the University of Basel for philosophy and theology and had graduated with M. A. in philosophy in 1671 and had received licentiate in theology in 1676.

At the same time he studied mathematics and astronomy. Later when his brother Johann Bernoulli entered Basel University for his studies, they together worked on Mathematics. Johann Bernoulli, born in 1667, was a Swiss Mathematician. Initially he enrolled in 1683 for studying medicine at the University of Basel. During this time he was attracted to Mathematics and started studying Mathematics under his brother Jacob Bernoulli who was a lecturer there [17].

3. Network Analysis of Data

In this section we convert all the information collected in the previous section into nodes and links between them. Using this data we draw the related network and further we analyze the data using the software Pajek. In the network we allow only connections between mathematicians and Institutions. Connections among different institutions or different mathematicians are irrelevant. So the resultant network is a bipartite network (see Fig. 1). All the 42 mathematicians are consecutively numbered from 1 to 42. Remaining nodes in the network are labeled from 43 to 58 so that they represent the higher educational institutions.

- | | |
|---------------------------|-----------------------|
| 1. Richard of Wallingford | 5. Johannes Muller |
| 2. Thomas Bradwardine | (Regiomontanus) |
| 3. Simon Bredon | 6. Nicolus Copernicus |
| 4. Georg Peurbach | 7. Michael Stifel |
| | 8. Peter Apianus |

- | | |
|-------------------------------------|--|
| 9. Christoff Rudolff | 34. Pietro Mengoli |
| 10. Erasmus Reinhold | 35. Johannes Hudde |
| 11. Franciscus Barocius | 36. Christiaan Huygens |
| 12. Christoph Clavius | 37. Isaac Barrow |
| 13. Guidobaldo Marchese del Monte | 38. Robert Hooke |
| 14. Michael Mastlin | 39. William Neile |
| 15. Luca Valerio | 40. Gottfried Wilhelm von Leibniz |
| 16. Nathaniel Torporley | 41. Ehrenfried Walther Von Tschirnhaus |
| 17. Galileo Galilei | 42. Johann bernoulli |
| 18. Giuseppe Biancani | 43. University of Basel |
| 19. Francois d' Aguilon | 44. University of Bologna |
| 20. Paul Guldin | 45. University of Bordeaux |
| 21. Frans van Schooten Senior | 46. University of Cambridge |
| 22. Orazio Grassi | 47. University of Coimbra |
| 23. Gregorie Saint –vincent | 48. University of Donai |
| 24. Albert Girard | 49. University of Gregorian |
| 25. Rene Descartes | 50. University of Leiden |
| 26. Jacobus Golius(Jacob Gool) | 51. University of Leipzig |
| 27. Henry Gellibrand | 52. University of Leuven |
| 28. Bonaventura Francesco Cavalieri | 53. University of Oxford |
| 29. Pierre de Fermat | 54. University of Padua |
| 30. William Brouncker | 55. University of Pisa |
| 31. Rene-Francois de Sluze | 56. University of Tübingen |
| 32. Jan de Witt | 57. University of Vienna |
| 33. Erasmus Bartholin | 58. University of Wittenberg |

Following is the list of arcs defined corresponding to the data.

43 42 1	50 25 1	53 27 1
44 6 1	50 26 1	53 30 1
44 34 1	50 32 1	53 38 1
45 29 1	50 33 1	53 39 1
46 37 1	50 35 1	54 3 1
47 12 1	50 36 1	54 11 1
48 19 1	50 41 1	54 13 1
49 15 1	51 5 1	55 17 1
49 18 1	51 8 1	55 28 1
49 20 1	51 40 1	56 14 1
49 22 1	52 31 1	57 4 1
49 23 1	53 1 1	57 9 1
50 21 1	53 2 1	58 7 1
50 24 1	53 16 1	58 10 1

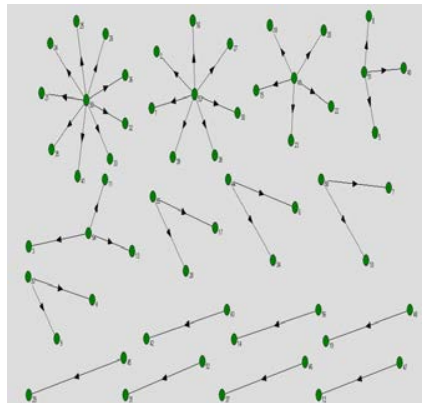


Figure 1: Network of University Education of European Mathematicians

4. Conclusion

We obtain the following information as a result of the analysis of the data. In the network nodes represent listed Mathematicians and the Universities. Arcs represent the connections of mathematicians to the Universities for acquiring knowledge, information and education. Their contacts for teaching and research are also taken into account in this study. Network all degree centralization of this network is 3.91 and total number of lines (arcs) 42. Also average degree is 1.45. At the same time, there are no institutions of higher learning in Kerala, during this period. This can be seen as a reason for backwardness of mathematics education and research in Kerala, in the later period.

Acknowledgment

This research was completed with the financial assistance of University Grants Commission, India. First author is grateful to University Grants Commission for sanctioning a major research project titled, "Modeling of social ties; a modified approach", No. F. No. 40 - 243/ 2011 (SR).

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- [7] Influenced by al-Khowarizmi and later Islamic writers who called the unknown [i.e., the variable x] shai, Arabic for "thing", Latin texts used res and those in Italian used cosa ("thing"). In Italy, algebra became known as larte della cosa, in England as cossike arte, or the rule of coss, and in Germany, die Coss." Jan Gullberg, *Mathematics: From the Birth of Numbers* (New York, New York: W.W. Norton, 1997), 299.
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