



SCHOOL OF INFORMATION SCIENCES
DEPARTMENT OF APPLIED INFORMATICS
MSc IN ARTIFICIAL INTELLIGENCE AND DATA
ANALYTICS

Epistemic Network Analysis: Literature Review and Case Study

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Outline

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- ▶ Literature Review
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Introduction(1)

- ▶ Computer programming is a creative but complex task and findings have shown that it can be facilitated with collaboration.
- ▶ Even though, chats provide rich information on the process of collaboration all these studies concerning collaborative programming have not analyzed chat data.
- ▶ Epistemic Network Analysis (ENA) is a network analysis technique that analyses logfile data and other records of individual and collaborative learning.
 - ENA models the connections between the discourse elements or codes by quantifying their co-occurrence producing a weighted network of co-occurrences.

Introduction(2)

- ▶ Objectives–Aim
 - Summarize, present and discuss the applications of ENA with a Literature Review.
 - Conduct a case study in order to examine the types of connections between codes during a collaborative code development.
 - Compare networks either groups of students or group categories with each other to find if there is significant difference between their discourse networks.
- ▶ There was no previous study that has analyzed students' discourse when working collaboratively to solve an Object Oriented Programming (OOP) assignment.
- ▶ We propose a coding scheme of OOP elements using the Epistemic Frame Theory in order to analyze how students collaborate using chat messages to solve an OOP assignment.

Epistemic Network Analysis (ENA)

(1)

- ▶ Assumptions for ENA
 - The structure of connections among cognitive elements is more important than the mere presence of absence of those elements in isolation.
 - Learning is defined not by the possession of isolated bits of knowledge and other competencies but the structure of connections among them.
- ▶ ENA is optimized for the analysis of networks too large to be analyzed using multivariate parametric techniques but not so large that can be analyzed only via summary statistics

Epistemic Network Analysis (ENA)

(2): Grammar and Characteristics

- ▶ Epistemic Frame Hypothesis: any community of practice has a culture, and that this culture has a grammar, which is composed of:
 - Skills: the things people within the community can do
 - Knowledge: the perceptions people in the community have
 - Identity: the way community members see themselves
 - Values: the beliefs of the community members
 - Epistemology: the credentials that explain actions or claims as valid within the community
- ▶ ENA has three basic assumptions:
 - it is possible to identify distinct features in data
 - the data analyzed have a local structure
 - the network elements have a significant data feature on which they are connected
- ▶ ENA has also the following three characteristics:
 - Codes: the researched features of the data
 - Units: can be either a group of participants or actions observed or a combination of the two, and
 - Stanza: is part of the data in which the coexistence of the codes is examined.

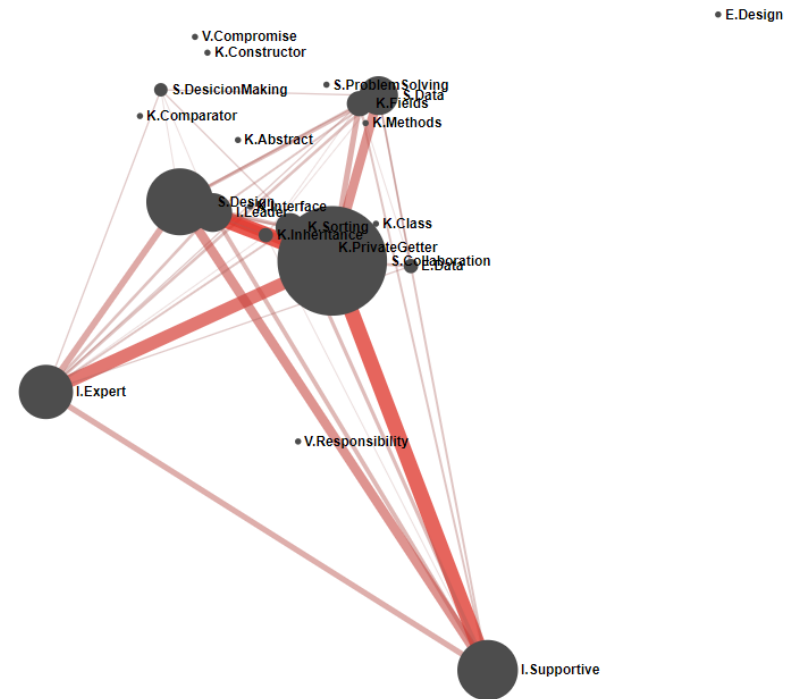
Epistemic Network Analysis (ENA)

(3)

- ▶ ENA creates an adjacency matrix that depicts the co-occurrences of codes per stanza.
- ▶ If a code co-occurs in a stanza, ENA assigns one, and zero if it does not.
- ▶ The adjacency matrices are summed up into a cumulative adjacency matrix. Each cell of the final matrix displays the number of stanzas in which that unique pair of codes was observed.
- ▶ ENA then converts cumulative adjacency matrices into cumulative adjacency vectors by projecting them into a high-dimensional space.

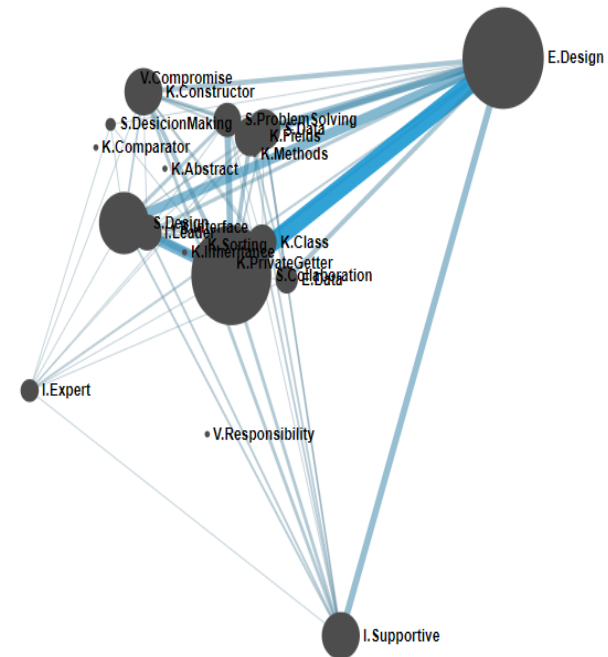
Epistemic Network Analysis (ENA) (4): A Simple Example Student A

- ▶ Consider Figure 1, which shows the cumulative cognitive network of an undergraduate student who participated in the research (Student A).
- ▶ This model of Student A shows strong connection between
 - The skill of collaboration and the skill of design
 - The identity of supportive and the skill of collaboration
 - The identity of expert and the skill of collaboration
 - The skill of collaboration and the skill of data
 - The identity of supportive and the skill of design



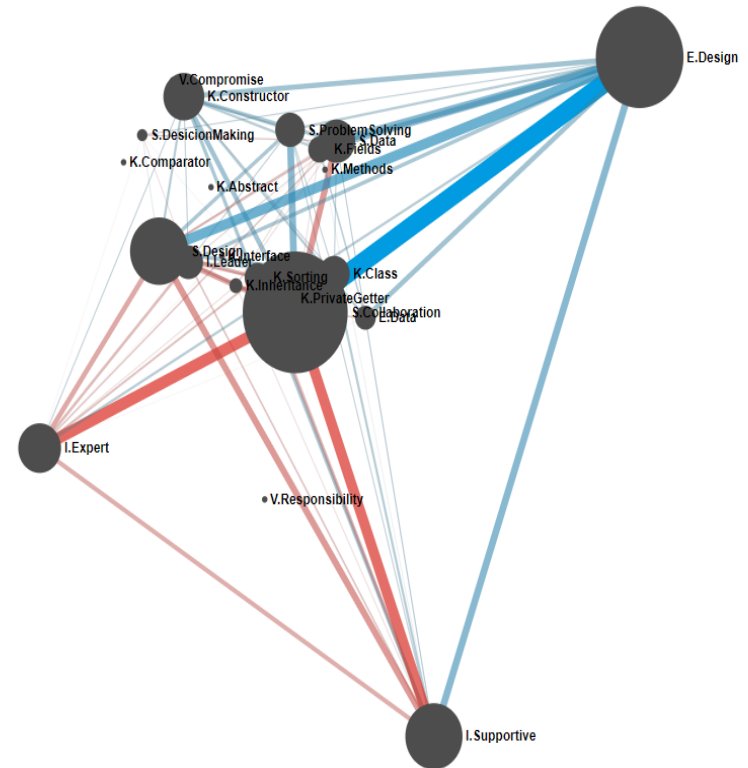
Epistemic Network Analysis (ENA) (5): A Simple Example Student B

- ▶ Consider Figure 2, which shows the cumulative cognitive network of an undergraduate student who participated in the research (Student B).
- ▶ This model of Student B shows strong connection between
 - The skill of data and the epistemology of design
 - The skill of collaboration and the epistemology of design
 - The skill of design and the epistemology of design
 - The skill of collaboration and the skill of design
 - The identity of supportive and the epistemology of design



Epistemic Network Analysis (ENA) (6): A Simple Example Comparison

- ▶ Student A has stronger connections between:
 - The identity of expert and the skill of collaboration
 - The identity of supportive and the skill of collaboration
 - The identity of supportive and the skill of design
 - The skill of collaboration and the skill of data
 - The identity of expert and the skill of design
- ▶ Student B has stronger connections between:
 - The skill of data and the epistemology of design
 - The skill of collaboration and the epistemology of design
 - The skill of design and the epistemology of design
 - The skill of collaboration and the skill of design
 - The identity of supportive and the epistemology of design.



Literature review(1)

- ▶ We summarize and present the literature review for ENA organizing the studies in four different categories.
 - Learning Analysis for Education
 - Teachers' Learning Analysis
 - Other Applications of ENA
 - Application of ENA for Medical Analysis

Literature review(2)

Title	Author(s)	Year of publication	Participants	Duration	Number of Sessions for Each Participant
Epistemic network analysis: A prototype for 21st-century assessment of learning.	Shaffer, D. W., Hatfield, D., Svarovsky, G. N., Nash, P., Nulty, A., Bagley, E., Frank, K., Rupp, A.A., Mislevy, R.	2009	-	80 Hours	-
Modeling learning progressions in epistemic games with epistemic network analysis: Principles for data analysis and generation.	Rupp, A. A., Choi, Y., Gushta, M., Mislevy, R., Bagley, E., Nash, P., Hatfield, D., Svarovsky, G., Shaffer, D. W.	2009	3 Groups (the number of participants is not mentioned)	-	87 Time Slices
Exploring complex	Svarovsky, G. N.	2011	1585 Schools through 2	4 Weeks	4 Sessions one for Eck

Title	Author(s)	Year of publication	Participants	Duration	Number of Sessions for Each Participant
Exploring connectedness: Applying ENA to teacher knowledge.	Orrill, C. H., & Shaffer, D. W.	2012	3 Teachers	-	1 Session
Exploring coherence in teacher knowledge using epistemic network analysis	Orrill, C., Shaffer, D. W., & Burke, J.	2013	7 Teachers	90 Minutes	1 Session
Supporting teachers' intervention in students' virtual collaboration using a network based model.	Herder, T., Swiecki, Z., Foug, S. S., Tamborg, A. L., Allsopp, B. B., Shaffer, D. W., & Misfeldt.	2018	3 Teachers	-	1 Session

Learning Analysis for Education: 28 Publications

Teachers' Learning Analysis: 7 Publications

Literature review(3)

Title	Author(s)	Year of publication	Participants	Duration	Number of Sessions for Each Participant
Toward a Historical Definition of Nutrition	Ruis, A. R.	2016	-	-	-

Title	Author(s)	Year of publication	Participants	Duration	Number of Sessions for Each Participant
The hands and head of a surgeon: Modeling operative competency with multimodal epistemic network analysis.	Ruis, A. R. , Rosser, A. A. , Quandt-Walle, C. , Nathwani, J. N. , Shaffer, D. W. , & Pugh, C. M.	2018	40 Participants	15 minutes	1 Session
Using epistemic network analysis to identify targets for educational interventions in trauma team communication.	Sullivan S. , Warner-Hillard C. , Eagan B. , Thompson R. , Ruis A. R. , Haines K. , Pugh C.M.	2018	80 Participants	-	-

Other Applications of ENA (Nutrition): 1 Publication

Application of ENA for Medical Analysis: 4 Publications

Literature review(4)

- ▶ Education
 - 2 Middle/ High School Students
 - 13 University Students
 - 8 College and University Students
 - 2 Students in General
 - 1 Visualization Tools for Educations
- ▶ Teachers
 - 2 Teacher Education in China
 - 3 Student–Teacher Internship
 - 2 Teachers Categorization (Advance Novice)
- ▶ Medical
 - 2 Doctors Categorization(Advance Novice)
 - 2 Medical Team Observation
- ▶ Gaze Coordination 2 Studies
- ▶ Other (Nutrition) 1 Study

Methodology of Case Study(1)

- ▶ 10 groups were selected where 37 students participated (7 groups with 4 students, 3 groups with 3 students)
- ▶ The participants formed groups of three or four members by themselves and they were asked to solve an exercise in Java using Eclipse Programming Platform for coding and Zoom Meeting Software for Communication.
- ▶ The participants in the research were rewarded according to their participation both in the solution of the assignment and their collaboration with 1.5 points.
- ▶ Students were divided into 4 categories based on their performance in the course of object-oriented programming and their performance in the assignment they solved;
- ▶ There are 3 different categories of groups based on members' individual and group scores. The Group10 was not analyzed in this case study. There were: High-to-High, High/Low-to-High, High/Low-to-Low
- ▶ The groups were also categorized based on the usage of the following three fundamental concepts of OOP: Abstract, Inheritance and Comparator. The categories in this case are: None, Inheritance, Abstract-Inheritance, Abstract-Inheritance-Comparator

Methodology of Case Study(2): The assignment

- ▶ The students had 90 minutes to solve the exercise and 15 minutes to upload the exercise and the meeting's chat on the LMS Open E-Class.

Άσκηση 1

Μια αλυσίδα καταστημάτων που πουλάει παιχνίδια (ελληνικής κατασκευής και εισαγόμενα) και παιδικά βιβλία ελληνικών εκδοτικών οίκων αποφάσισε να υλοποιήσει μια απλή εφαρμογή για τη διαχείριση των στοιχείων των προϊόντων της.

Σε πρώτη φάση απαιτείται ο υπολογισμός της τελικής τιμής των προϊόντων που πουλάει η αλυσίδα και η έκπτωση ετικετών, όπως φαίνεται παρακάτω:

***** Παιχνίδι ***** The island (Επιτραπέζιο παιχνίδι) Age 7+ 48.0 Euro	***** Βιβλίο ***** Εκπληκτικοί δεινόσαυροι (Βιβλίο παζλ) Poetica Ars 12.75 Euro
***** Παιχνίδι ***** SPIDERMAN (Λούτρινο) Age 3+ 20.0 Euro	***** Βιβλίο ***** Αλφαβητάριο Α' Δημοτικού (Σχολικό) Μαρία Νικολάου 11.50 Euro

Για τον υπολογισμό της τελικής τιμής που εμφανίζεται στην ετικέτα να λάβετε υπόψη ότι:

1. Αν ένα παιχνίδι είναι ελληνικής κατασκευής τότε η τελική τιμή συμπίπτει με την αρχική, ενώ αν είναι εισαγόμενο η αρχική τιμή προσαυξάνεται κατά 20%. Για παράδειγμα, για ένα εισαγόμενο παιχνίδι με αρχική τιμή 40 ευρώ, η τελική τιμή θα είναι 48 ευρώ.
2. Η αλυσίδα των καταστημάτων έχει συμφωνήσει με κάποιους εκδοτικούς οίκους συγκεκριμένο ποσοστό έκπτωσης. Για παράδειγμα, για ένα βιβλίο με αρχική τιμή 15 Ευρώ και έκπτωση 10%, η τελική τιμή θα είναι 13.5 ευρώ.

Για τα προϊόντα που πουλάει η αλυσίδα καταστημάτων ζητήθηκε να υπάρχει η δυνατότητα:

3. εμφάνισης του ταξινομημένου καταλόγου όλων των παιχνιδιών και των βιβλίων σύμφωνα α) με την ονομασία και β) σύμφωνα με την τιμή τους (σε αύξουσα διάταξη)
4. εμφάνισης των παρακάτω στατιστικών στοιχείων: μέση τιμή βιβλίων, μέση τιμή παιχνιδιών, και τιμή ακριβότερου παιχνιδιού.

Ο χρήστης θα έχει τη δυνατότητα να εισάγει τα στοιχεία ενός νέου προϊόντος από το πληκτρολόγιο. Να ορίσετε την κλάση ProductsCatalogue η οποία θα διαχειρίζεται την εισαγωγή των δεδομένων (χρήση ArrayList) και θα υλοποιεί τα 3 & 4.

Για την ανάπτυξη της εφαρμογής θα πρέπει να υλοποιήσετε επιπλέον τις κλάσεις για παιχνίδι, βιβλίο και να αξιοποιήσετε την κληρονομικότητα, τις αφηρημένες κλάσεις και τις διασυνδέσεις
Ελέγξτε την ορθότητα της εφαρμογής σας καταχωρώντας τα παραπάνω προϊόντα.

Methodology of Case Study(3): students' scores, assignment score, groups' Categories

Students were divided based on their grade point average in the course which was 7.2 / 10 and based on the assignment grade point average which was 7.8 / 10.

	Member1: score in OOP course/cat egory	Member2: score in OOP course/categ ory	Member3: score in OOP course/categ ory	Member4: score in OOP course/categ ory	Group score in the assignm ent	Category of the Group
Group1	10/High	10/High	10/High	-	9/High	High-to-High
Group2	4/Low	4/Low	6/Low	10/High	5.5/ Low	High/Low-to-Low
Group3	4/Low	9/High	10/High	10/High	7.5/ Low	High/Low-to-Low
Group4	4/Low	4/Low	10/High	10/High	8.5/ High	High/Low-to-High
Group5	8/High	10/High	10/High	10/High	8.5/ High	High-to-High
Group6	4/Low	7/Low	8/High	10/High	5/Low	High/Low-to-Low
Group7	4/Low	5/Low	7/Low	10/High	8.5/ High	High/Low-to-High
Group8	9/High	9/High	10/High	-	8.5/ High	High-to-High
Group9	4/Low	10/High	10/High	-	10/ High	High/Low-to-High
Group10	4/Low	4/Low	6/Low	6/Low	8/High	Low-to-High

Methodology of Case Study(4): Log Data

- The columns of the file apart from the codes used for ENA (see Coding Scheme) are; GroupID, Exersice, Object-Oriented Programming, Team Members, Student Categ, Category2, Inh/Abs/Comp, Time, User and Chat. The total lines of the discourse were 2800.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	GroupID	Exersice	Object-Oriented Programming	Exersice	Team Members	Student Categ	Inh/Abs/Comp	Time	User	Chat	Codes	K.Sorting	K.Class	K.Abstract	Inheritance
1															
2	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:01:21		je kin	-	0	0	0	0
3	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:01:23		καλημέρα!	-	0	0	0	0
4	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:01:37		καλησπέρα	-	0	0	0	0
5	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:03		ας μιλάμε από δω	-	0	0	0	0
6	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:09		φαίνεται η οθονη ετι-	-	0	0	0	0
7	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:16		να	-	0	0	0	0
8	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:24		ωραία	S.Collaboration,I.Leader	0	0	0	0
9	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:24		βλ/ηουμε το ορεπε-	-	0	0	0	0
10	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:45		επρεπε να το παιξεις	-	0	0	0	0
11	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:45		ωραία	-	0	0	0	0
12	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:04:59		πρέπει να είμαστε κτ-	-	0	0	0	0
13	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:05:06		δεν νομίζω	-	0	0	0	0
14	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:05:11		Ή μονο για απορίες	-	0	0	0	0
15	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:05:19		το 2ο πιστευω	-	0	0	0	0
16	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:05:53		έγινε	-	0	0	0	0
17	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:06:30		Οράα ανοιγουμε ολ S.Collaboration,I.Leader	-	0	0	0	0
18	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:08:30		εστε πως να χουμε το-	-	0	0	0	0
19	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:08:39		Όχι	-	0	0	0	0
20	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:08:44		αν εννοεις να φιανετ-	-	0	0	0	0
21	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:09:00		Εγώ διαβάω ακομα	-	0	0	0	0
22	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:09:17		εγω την διαβασα	-	0	0	0	0
23	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:09:33		μπραβο φτιαξε τη mi.K.Methods, K.Class, I.Leader	-	0	1	0	0
24	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:10:00		να φτιαξουμε κλαση K.Class, I.Quandary	-	0	1	0	0
25	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:10:01		και σιγουρα μια κλαα K.Class, E.Design, I.Leader	-	0	1	0	0
26	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:10:10		και να κληρνονομη η S.ProblemSolving, K.Inheritance, I.Quandary	-	0	0	0	1
27	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:10:17		να συμφωνω	E.Design, S.Collaboration,	0	0	0	0
28	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:10:37		ωραία	E.Design	0	0	0	0
29	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:10:50		αφήνω την product	K.Class	0	1	0	0
30	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:11:07		η item θα εχει ονομα K.Fields, I.Expert	-	0	0	0	0
31	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:11:13		για γνωριμοτα	K.Fields, I.Expert	0	0	0	0
32	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:11:20		ωραία	E.Design	0	0	0	0
33	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:11:23		φτιαξε τους construc	K.Constructor	0	0	0	0
34	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:12:03		τι εχει το book?	K.Class	0	1	0	0
35	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:12:13		εξδοτη?	K.Fields	0	0	0	0
36	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:12:14		Ονομα	K.Fields, S.Design	0	0	0	0
37	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:12:22		τιμη	K.Fields, S.Design	0	0	0	0
38	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:12:30		syggrafea	K.Fields, S.Design	0	0	0	0
39	Group1	Exersice1		10	9	3 High-to-High	Abstract,inheritance	0:12:30		εναυμε μινουο	S.DecisionMaking, E.Design	0	0	0	0

Methodology of Case Study(5): Coding scheme

Knowledge: the perceptions that people share in the community

- K.Abstract, K.Comparator, K.Constructor, K.Class, K.Fields, K.Getter, K.Inheritance, K.Interface, K.Methods & K.Sorting

Identity: the way community members see themselves

- I.Expert, I.Leader, I.Quandary & I.Supportive

Skills: the things people do in the community

- S.Collaboration, S.Data, S.DesicionMaking, S.Design & S.ProblemSolving

Epistemology/Confirmation: the guarantees that confirm actions or beliefs, as legitimate, within the community

- E.Data & E.Design

Values: the beliefs held by members of the community

- V.Compromise & V.Responsibility

Research Questions

- ▶ RQ1a. What types of connections between codes are made by each students' Group?
- ▶ RQ1b. Is there a significant difference between the discourse networks of ten different students' groups?
- ▶ RQ2a. What types of connections between codes are made by groups in the High-to-High category? What types of connections between codes are made by Groups in the High/Low-to-High category? What types of connections between codes are made by Groups in the High/Low-to-Low category?
- ▶ RQ2b. Is there a significant difference between the discourse networks of groups of the three categories: High-to-High, High/Low-High and High/Low-Low?
- ▶ RQ3. Is there a significant difference between the discourse networks of groups of the same Category?
- ▶ RQ4. Is there a significant difference between the discourse networks between the category of the Groups based on the fundamental OOP concepts they used?

Results(1)

RQ1 a. What types of connections between codes are made by each student's Group?

The stronger connection for each group is;

The connection between the Skill of Collaboration and the Skill of Design

Group1 (S.Collaboration-S.Design: 0.439)

Group2 (S.Collaboration-S.Design: 0.393)

Group3 (S.Collaboration-S.Design: 0.394)

Group4 (S.Collaboration-S.Design: 0.428)

Group5 (S.Collaboration-S.Design: 0.459)

Group7 (S.Collaboration-S.Design: 0.447)

Group8 (S.Collaboration-S.Design: 0.440)

The connection between the Skill of Collaboration and the Identity of Supportive

Group6 (S.Collaboration-I.Supportive: 0.471)

Group9 (S.Collaboration-I.Supportive: 0.458)

Group10 (S.Collaboration-I.Supportive: 0.475)

Results(2)

RQ1 b. Is there a significant difference between the discourse networks of Group1 and the other nine different students' Groups?

- ▶ In all the cases, except of the comparison with the Group2, the statistical tests confirm that there are statistically significant differences between Group1 and the other groups.
- ▶ The members of Group 1 focused more on the Methods of the OOP because there are strong connections between Knowledge of Methods and the Skills of Design.
- ▶ The rest of the groups in general had stronger connections with the Epistemology codes and the Identity of Supportive.

Results(3)

RQ2a. What types of connections between codes are made by groups in the High-to-High category? What types of connections between codes are made by Groups in the High/Low-to-High category? What types of connections between codes are made by Groups in the High/Low-to-Low category?

High-to-High

- The nodes that had the strongest connections in the High-to-High category network are S.Design, I.Expert, I.Supportive, S.Collaboration, and E.Design.
- The connections with the Design codes indicate the students' abilities as a result of their performance in the OOP course. Overall, there were dense connections between the Knowledge Codes in this category.

High/Low-to-High

- The nodes that had the strongest connections in the High/Low-to-High category network are S.Design, I.Expert, I.Supportive, S.Collaboration, E.Design.
- All the connections with S.Design indicate the design abilities of students'. The connections with E.Design confirm the design ideas proposed.

High/Low-to-Low

- The strongest connection in the category High/Low-to-Low is between E.Design and S.Collaboration.
- In this category there were stronger connections with the E.Design than the S.Design code, indicating that these students did not have strong enough design abilities but preferred to simply confirm the proposals of other team members.

Results(4)

RQ2b. Is there a significant difference between the discourse networks of groups of the three categories: High-to-High, High/Low-High and High/Low-Low?

High-to-High and High/Low-High

- In the case of the High-to-High and High/Low-High the two categories are not significantly different.
- More specifically in the High-to-High category there are more connections between the knowledge codes and also skills like collaboration, design and data.

High-to-High and High/Low-Low

- In the case of High-to-High and High/Low-Low the two categories are not significantly different.
- More specifically in the High-to-High category there are more connections between the knowledge codes and also skills like collaboration, design and data.
- The High/Low-Low has fewer connections from the previous one and the most important one is between the skill of collaboration and the epistemology of design.

High/Low-High and High/Low-Low

- In the case of High/Low-High and High/Low-Low the two categories are not statistically different. There are although differences between the two.
- In the High/Low-High category there are more connections between the knowledge codes, the user identities and also skills like collaboration and design.
- As for the High/Low-Low there are only 3 important connections: between the skill of data and the knowledge of fields, between the skill of data and collaboration, between the skill of data and the epistemology-confirmation of design.

Results(5)

RQ3. Is there a significant difference between the discourse networks of groups of the same Category?

High-to-High (Group1, Group5 & Group8)

- In the High-to-High category groups seem to be significantly different cause to the identity roles, the epistemology and the collaboration skills.
- Groups 5 and 8 have more pronounced the supportive identity which means that all the members helped the other if needed.

High/Low-to-High (Group4, Group7 & Group9)

- The groups of the High/Low-to-High category have no big differences and their main characteristics are strong connection between the skills of collaboration, the epistemology-confirmation and the skill of design and the identities of supportive and the expert

High/Low-to-Low (Group2, Group3 & Group6)

- The groups of the High/Low-to-Low category seem to be significantly different cause to the skill of data, the epistemology of design and the supportive identity.
- Groups 3 and 6 have more pronounced the supportive identity which means that all the members helped the other if needed.
- As for the Group 2 the epistemology of design and the data handling skill are more profound.

Results(6)

RQ4. Is there a significant difference between the discourse networks between the categories of the Groups based on the fundamental OOP concepts they used?

Significantly
Different

- Abstract, Inheritance – Abstract, Inheritance, Comparator
- Abstract, Inheritance – Inheritance
- Abstract, Inheritance, Comparator – None
- Inheritance – None

Non
Significantly
Different

- Abstract, Inheritance, Comparator – Inheritance
- Abstract, Inheritance – None

Conclusions

- ▶ The Literature Review on ENA summarized applications in different fields mainly in the Education for both students and teachers and also in the Medical field.
- ▶ The results of the Case Study showed that there was significant difference among the discourse networks of the majority of groups comparing with the discourse network of Group 1.
- ▶ Also the comparison of the discourse networks of different categories of groups based on the students' course and assignment scores, showed that there was not significant difference between all of them.
- ▶ However, the comparison of discourse networks of groups that belong to the same category of high-performance, or mixed-performance, or low-performance categories, for the most part did not show significant differences.
- ▶ Regarding the comparison of the discourse networks of the different categories of groups, based on the use of fundamental concepts of OOP, the differences between them were significant.

Limitations & Future Extensions

▶ Limitations

- The data collected and analyzed were only text messages.
- Any conclusions drawn from the findings regarding students' abilities are limited to the study sample which participated in solving the assignment
- The small sample size (37) of the participants may have led to non-significant results during comparative analysis.

▶ Extensions

- The analysis of the second exercise and the integration into the already existing data so that additional conclusions can be drawn.
- A more rigorous analysis of the dialogues based on both the interpretation given and the actual interpretation performed by experts in order to avoid the risk of prejudice and to result in unbiased analyzes.

References

- ▶ <https://www.epistemicnetwork.org/publications/>

Thank You

