

Towards Teaching Analytics: Repertory Grids for Formative Assessment (RGFA)

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Abstract: In this paper, we present a short description of RGFA, a web-based software implementation of the Repertory Grid method. RGFA facilitates the study of the personal constructs of students for spatial diagnosis of their knowledge levels. Repertory Grid is a method for eliciting personal constructs of learners about elements belonging to the topic of study. Repertory Grid and RGFA are a pedagogical method and a computational tool respectively of the NEXT-TELL EU project (www.next-tell-eu) that is concerned with technology enhanced formative assessment and pedagogical decision-making. System description, use cases, and an illustrative screenshot of RGFA are presented. The paper concludes with an outline of future work on the research and development of RGFA.

Introduction

Repertory Grid Technique (hereafter RGT) is a method for eliciting personal constructs of individuals about elements belonging to the topic of study. RGT is based on the seminal contribution of the Personal Construct Theory of the psychologist George Kelly (Kelly, 1963, 1992) and subsequent theoretical and methodological developments (cf. Adams-Webber, 2006; Fransella, Bell, & Bannister, 2003). RGT has been used by both researchers and practitioners in a wide variety of fields including psychotherapy (Winter, 2003), marketing (Frost & Braine, 1967), education (Bell & Harriagstein, 1990; Mazhindu, 1992), and information systems (Cho & Wright, 2010; Tan & Hunter, 2002).

RGT consists of a family of methods and variations involving the nature of the personal construct elicitation and the rating or ranking of elements in monadic, dyadic or triadic configurations (Fransella, et al., 2003). For the purposes of formative assessment, we have decided to start researching RGT with an implementation of the widely adopted method of triadic sorting of elements for personal construct elicitation and subsequent five-point Likert-item rating of the rest of the elements (Fransella, et al., 2003).

Repertory Grids for Formative Assessment (RGFA)

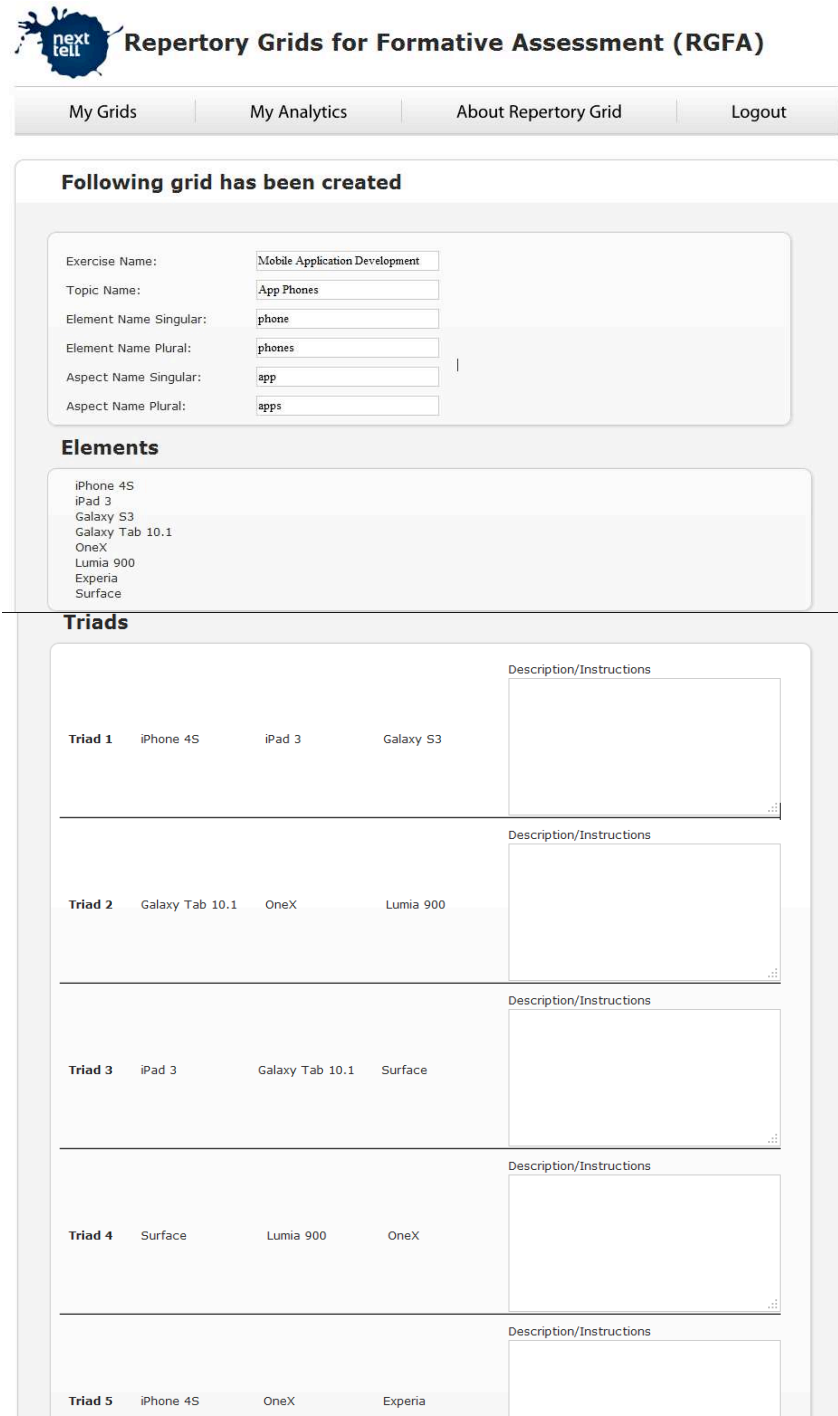
RGFA (<http://cssl.cbs.dk/software/>) is designed and developed to achieve three interdependent research and development objectives for the use of repertory grid technique for technology enhanced formative assessment.

1. Integration of Repertory Grid into the curriculum as an in-class learning activity or a take-home exercise.
2. Methodological support for teachers to designing and deploying RGT exercises.
3. Computational support for visualizing the Repertory Grid data at the individual student and whole classroom level for formative assessment purposes for teachers and self- and collaborative learning purposes for students.

System Description

With RGFA, teachers can design Repertory Grid Exercise with a combination of elements ranging from text, pictures, and videos. The teacher specifies the elements and then configures one or more triads (combinations of three elements). Once the exercise is saved, the teacher can email the link to it to the class or share the exercise link through the course portal. When the students begin the Repertory Grid Exercise, they are presented with the triads (the sets of three elements specified by the teacher). For a given set of three elements (e.g., Windows, OSX, Linux), the student is prompted to select the element (e.g., Linux) that is different from the other two (Windows, OSX) and to state how it is different as the “opposite construct” (e.g., “command line interface”). Then, the student has to state how the two remaining elements in the triad are similar to each other as the “similarity construct”. The rest of the elements (other operating systems, in our example) are then rated on a Likert-item scale ranging from the Opposite Construct (1) to the Similarity Construct (5). The students repeat this process until all the triads of elements are sorted into different and similar and the elements for that comparison are rated. The outcome of this exercise is the Repertory Grid Table (RGT) consisting of rows with triads, columns consisting of elements with the first column being the Opposite Construct and the last column

being the Similarity Construct, and the cell values consisting of the ratings given for elements. The current implementation of the teaching analytics support for RGFA displays time taken for construct elicitation and element rating phases for each triad and colors the cells with the shortest time taken in green and the longest time taken in red. Based on the RGT, the teacher can qualitatively appraise learners' "mental models"—what they see as 'going together', and on what dimensions—and/or apply clustering methods or dimension reduction methods to derive quantitative measures of learners' knowledge structures. The color coded time on task (construct elicitation) and element rating can be used to diagnose problematic triads and "conceptual gaps". Figure 1 shows a repertory grid exercise designed by a teacher. Figure 2 presents a screenshot of a completed repertory grid exercise by a student. Figure 3 shows the teaching analytics support.



next tell Repertory Grids for Formative Assessment (RGFA)

My Grids | My Analytics | About Repertory Grid | Logout

Following grid has been created

Exercise Name: Mobile Application Development

Topic Name: App Phones

Element Name Singular: phone

Element Name Plural: phones

Aspect Name Singular: app

Aspect Name Plural: apps

Elements

iPhone 4S
iPad 3
Galaxy S3
Galaxy Tab 10.1
OneX
Lumia 900
Experia
Surface

Triads

Triad	Element 1	Element 2	Element 3	Description/Instructions
Triad 1	iPhone 4S	iPad 3	Galaxy S3	
Triad 2	Galaxy Tab 10.1	OneX	Lumia 900	
Triad 3	iPad 3	Galaxy Tab 10.1	Surface	
Triad 4	Surface	Lumia 900	OneX	
Triad 5	iPhone 4S	OneX	Experia	

Figure 1. Example of a Repertory Grid Exercise

Triad #	Triad	Opposite Construct	A	B	C	D	E	F	G	H	Similarity Construct	Triad	Triad#
Triad 1	iPhone 4S, iPad 3, Galaxy S3	iPad is a tablet and not a phone (1)	5	1	5	1	5	5	5	2	Both are smart phones (5)	iPhone 4S, iPad 3, Galaxy S3	Triad 1
Triad 2	Galaxy Tab 10.1, OneX, Lumia 900	is a tablet (1)	5	1	5	1	5	5	5	2	is a smart phone (5)	Galaxy Tab 10.1, OneX, Lumia 900	Triad 2
Triad 3	iPad 3, Galaxy Tab 10.1, Surface	is a not yet released product (1)	3	5	3	5	3	3	3	1	is a released tablet product (5)	iPad 3, Galaxy Tab 10.1, Surface	Triad 3
Triad 4	Surface, Lumia 900, OneX	it is a tablet (1)	5	1	5	1	5	5	5	1	it is a smart phone (5)	Surface, Lumia 900, OneX	Triad 4
Triad 5	iPhone 4S, OneX, Experia	it has IOS as operating system (1)	1	1	5	5	5	3	5	3	it has Android as operating system (5)	iPhone 4S, OneX, Experia	Triad 5

Triad #	Triad	Time for constructs	Time for the ratings	Total time for triad	Total time all
Triad 0	iPhone 4S, iPad 3, Galaxy S3	00:00:41	00:01:01	00:01:43	
Triad 1	Galaxy Tab 10.1, OneX, Lumia 900	00:00:25	00:00:21	00:00:46	
Triad 2	iPad 3, Galaxy Tab 10.1, Surface	00:01:22	00:00:35	00:01:58	
Triad 3	Surface, Lumia 900, OneX	00:00:54	00:00:21	00:01:16	
Triad 4	iPhone 4S, OneX, Experia	00:00:56	00:00:33	00:01:30	

Figure 2. Repertory Grid Completed by a Student (Green coloured Cell indicates longest time taken and red coloured cell indicates shortest time taken)

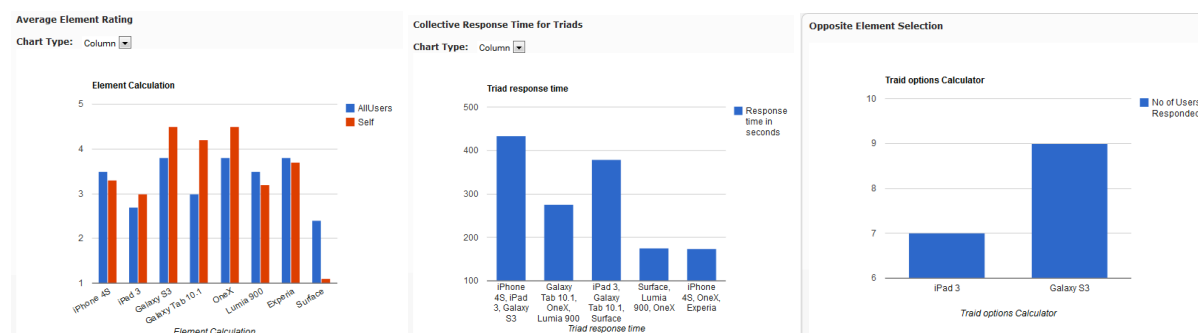


Figure 3. Teaching Analytics Support (Self vs. Class Comparison; Collective Response Time for the Class; and Opposite Element Selection Frequency Indicator)

Suggestions for Teachers

In designing repertory grid exercises, teachers should pay particular attention to the previous domain knowledge of students and to what extent the elicited constructs are grounded in the personal lived experience of the students compared to the domain knowledge. An ideal repertory grid exercise would involve 6-10 elements and 5-6 triads with each element appearing at least once and in different positions of the triad when a particular element features more than once across the different triads. The repertory grid exercise could be designed for individual students or as a computer supported collaborative learning (CSSL) exercise involving a small group of students. The pre-test and post-test paradigm could be applied to solicit individual or group repertory grids before and after a particular curriculum module has been taught. Further, the teacher can make his or her own repertory grid to the students for reflection and repertory grids of domain experts for benchmarking and guided inquiry. Post repertory grid exercise tasks could include asking the individual students or groups to reflect on their own repertory grids, inspect the repertory grids of their peers or domain experts, and/or inspect the visualizations of the repertory grids for the entire class. An additional implication from the classroom exercises

and the eye-tracking laboratory studies is that teachers could also learn about students' current understanding based on the time take for construct elicitation and element rating (Vatrapu, Reimann, & Hussain, 2012).

With regard to formative assessment, teachers can inspect the constructs or the Word Cloud representations of the individual or collective constructs and discern students' level of domain knowledge. Similarly, teachers can scrutinize the elements ratings to discern students' ability to distinguish between the different concepts. With necessary training, teachers can make use of Treemap or some other visualization of the entire repertory grid exercise to adapt the content and didactics for that particular curriculum module.

Apart from the classroom usage scenario, another usage scenario for teachers is to employ the repertory grid exercise as lightweight appraisal method for informal learning tasks. We will research this usage scenario in future work with teachers participating in the NEXT-TELL project and demonstrate it at CSCL 2013.

Suggestions for Students

Repertory grid exercises on topics not inherently familiar to students either from prior formal learning settings or from personal experience seem to be perceived as challenging and engaging. That said, a well-designed repertory grid exercise on the familiar and lived practice would allow students to externalize their implicitly held constructs. Students should then be motivated and guided to reflect on their intuitions and connect their personal constructs to domain concepts.

Students should also be able to co-design repertory grid exercises with peers and teachers. Co-designing a repertory grid exercise would require students to select the topic, the elements, and the number, content and order of triads. This in itself could be pedagogically effective.

Finally, students should be given the option of sharing their repertory grids with their classmates and within their social networks. Students should be able to interact with their visualizations of their individual repertory grids and those of their peers and the classroom level repertory grid. Moreover, students should be able to upload their repertory grid exercises to their e-portfolios and integrate them with their open learner models.

Future Work

- Implement support for text analytics of the elicited personal constructs
- Implement support for detection of Zones of Proximal Development
- Implement support for collective analysis of Repertory Grid Tables
- Provide support for Principal Component Analysis and Multi-Dimensional Scaling

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Appendix: Demonstration Plan

Demo Set-up

We plan to bring two large 24" monitors, two laptops, a power strip, 2-3 iPads, and 2-3 Windows 8 tablets, and set up our own WiFi network with mobile broadband. The first laptop and monitor will show a presentation of RGFA together with a short video tutorial on a continuous loop. The second monitor and laptop will serve as the primary demonstration machine. Parallel demo sessions will be set up on the iPads and the Windows 8 tablets.

Interaction plan

Repertory Grid Technique is a method for eliciting personal constructs of individuals about elements belonging to the topic of study. Within the NEXT-TELL project, for the purposes of formative assessment, we have decided to start researching RGT with an implementation of the widely adopted method of triadic sorting of elements for personal construct elicitation and subsequent five-point scale rating of the rest of the elements (Fransella, et al., 2003). Briefly put, the triadic sorting method consists of the participants being presented sets of three elements each. For a given set of three elements, the participant is prompted to select the element that is different from the other two and to state how it is different as the "opposite construct". Then, the participant is to state how the two remaining elements in the triad are similar to each other as the "similarity construct". The rest of the elements are then rated on a Likert-item scale ranging from the Opposite Construct (1) to the Similarity Construct (5). The participants repeat this process until all the triads of elements are sorted into different and similar and the elements for that comparison are rated. The outcome of this exercise is the Repertory Grid (RG) consisting of rows consisting of triads, columns consisting of elements with the first column being the Opposite Construct and the last column being the Similarity Construct, and the cell values consisting of the ratings given for elements.

We seek to demo two usage scenarios for RGFA. First, the intended use of RGFA as a spatial diagnostic tool of students' knowledge levels. Second, we would like to demo potential uses of RGFA for inquiring into personal conception of HCI constructs such as usability assessment methods and user experience methods, requirements gathering, and as a participatory design tool.

We expect to have a localized version of RGFA supporting English, Danish, Norwegian, and German available by the time of the NordiCHI 2012 conference. In general, the following workflow for creating a RGFA exercise will be demonstrated as well as the completion of a RGFA exercise.

1. Visit
 - a. Danish: <http://cssl.cbs.dk/software/rgfa/Login.aspx?Countrycode=DK>
 - b. English: <http://cssl.cbs.dk/software/rgfa/Login.aspx?Countrycode=GB>

User Instructions

The instructions below are for the English version but the steps are identical to the Danish version.

2. Select "Teacher" from the drop down box. (Figure 1)
3. Use "demo" as the userid and "nextell" as the password (Figure 2)
4. Click on "Create new Repertory Grid Exercise" link on My Grids page (Figure 3)
5. Enter the names for exercise, topic, element and aspects (singular & plural) (Figure 4)
6. Enter number and names of element (Figures 5)
7. Enter the number of Triads and specify the Triads (Figure 6)
8. View the completed Grid (Figure 7)
9. Click on My Grids and select Copy+Paste the link under "CompleteGrid Link" column
9. Send the following instructions to the students:
 - Click on the link below:
 - <Copy+Paste the link under CompleteGrid Link>
 - Select "Student" from the drop down list and the do the new student signup.
 - Follow the on-screen instructions to complete the exercise (Figures 8 & 9)
10. Under "My Grids" Select the Exercise under "Completed Grids" and click on "View" to see students' grids.