Students' Profiles in the Chemistry Laboratory Environments: Moving from a Phenomenographic to a Quantitative Assessment

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Background

Chemistry education researchers have called for a more comprehensive look at the laboratory environment in chemistry[1]. It was found that there is a disconnect with faculty goals for the laboratory and what students perceive the goals of the laboratory to be[2-4]. More recently, we described eight student perspectives of the laboratory using the qualitative research methodology of phenomenography published in the journal "Chemistry Education Research and Practice" (Authors, 2017). Based on a sample of n = 18 students, perspectives that have been established are:

- Apathetic: Uninterested in the lab
- Time Saver: Focus on efficiency and saving time
- Detail Oriented: Focus on acquiring more details of lab procedures and experiments
- Skill Developer: Developing technical skills for future career
- Socialite: Importance on Social interactions in lab
- Mastery: Focus on using the laboratory to deepen conceptual understanding
- Independent Researcher: Cultivating independence in the lab
- Explorer: Exploring the unknown in science and embraces ambiguity

The current state of our research, however, allows no statements about how these perspectives might be correlated on a group level and whether students, having experienced chemistry labs in the undergraduate level, can be grouped with regard to holding one or another perspective.

Research Questions

1. Which statistical characteristics does a questionnaire that assesses students' perspectives of chemistry laboratory environments have?
2. How are these student perspectives correlated?
3. Which subgroups of students can be identified using the perspectives?

Questionnaire Development Statements

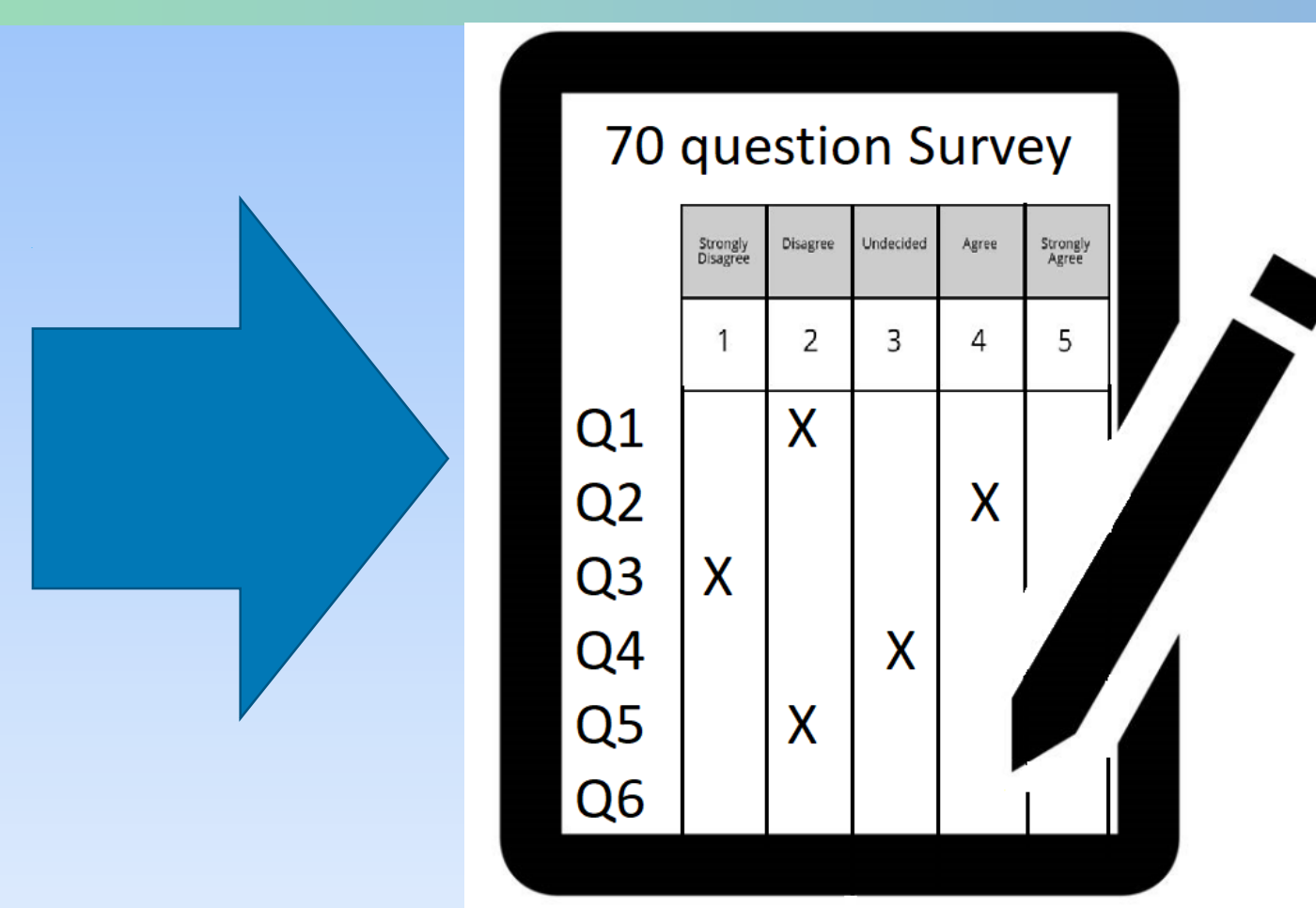| Student Perspective	Direct Interview Quote	Generated survey statement
Socialite	"...compare your stuff to other people's stuff. And maybe if you really don't want to talk to them, just at least look at stuff. I mean I would definitely say, like, you are hurting yourself by not talking to other people"	I frequently check with other students about their progress in lab
Independent	I liked that everybody had something different because everybody was focused on their own stuff and not peaking over at what your doing so	I prefer having my own compounds/unknowns in lab that is different from everyone else's

Questionnaire Development

Student Perspectives
- ✓ Mastery
- ✓ Independent Researcher
- ✓ Explorer
- ✓ Socialite
- ✓ Skill Developer
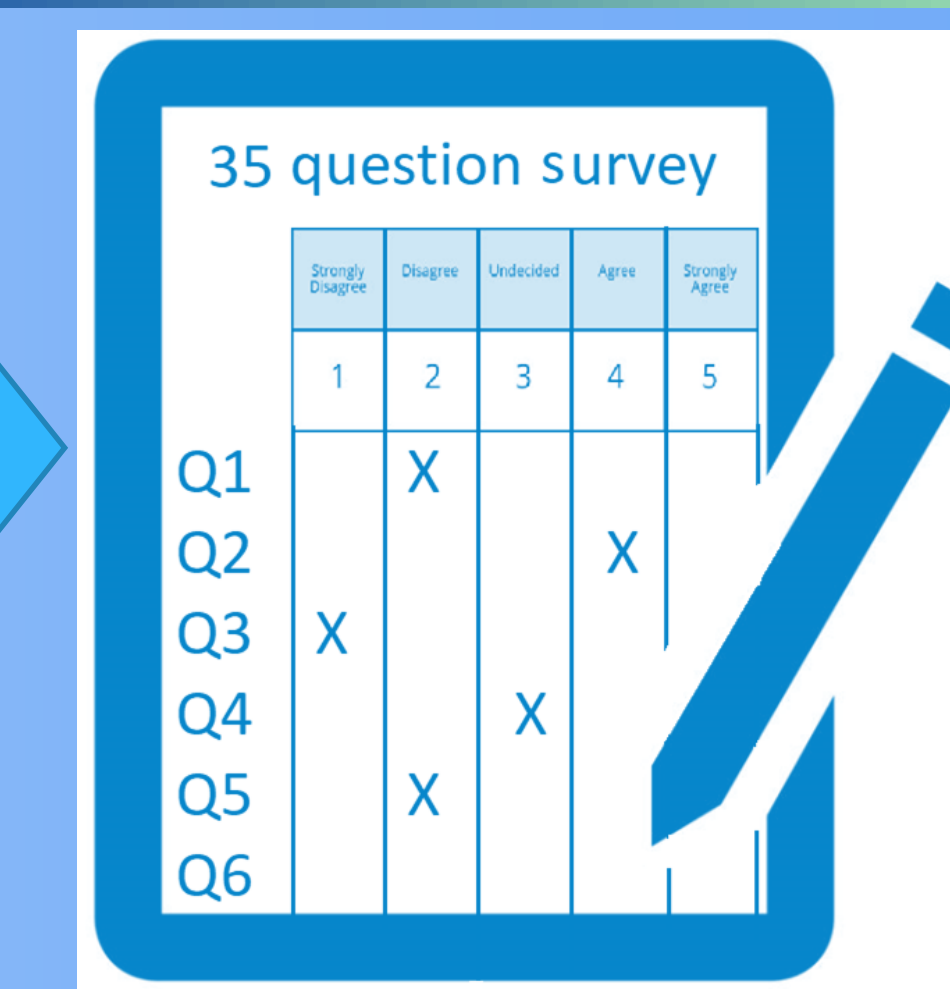- ✓ Detailed oriented
- ✓ Timesaver
- *Apathetic

70 question Survey

Pilot Interview (2 phases)
1. Qualitative
   - Readability
   - Understanding
   - Reasons behind answer selection
2. Quantitative
   - N=56 (German)
   - Item discrimination
   - Statistical analysis for homogenous scale
   - Factor Analysis
   - Reliability (Cronbach's alpha)

35 question survey

Development of Statements
Ten statements were developed for each of the perspectives identified in the study

Results

RQ1: Statistical Characteristics

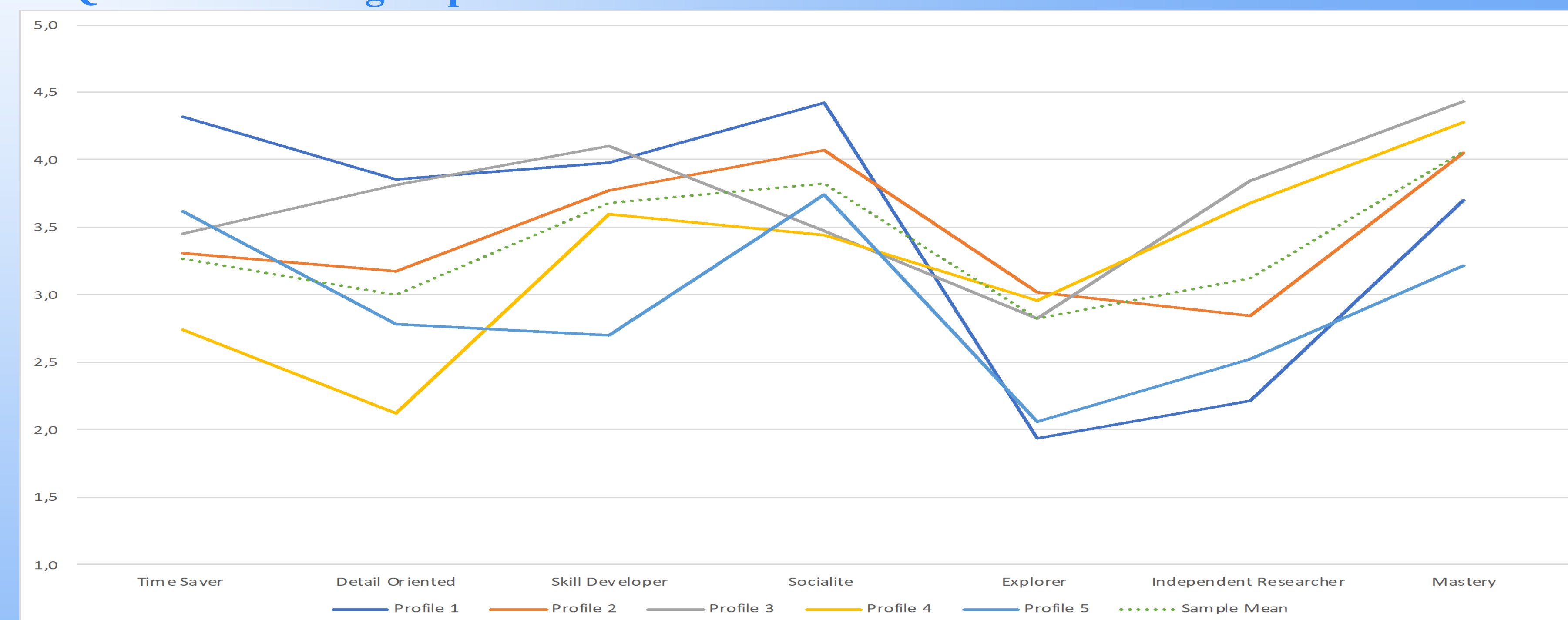| Perspective	Range of item means and standard deviations	Item discrimination Range	Reliability of scale
Time Saver	$3.0 < M_{Timesaver} < 3.4$ $1.0 < SD_{Timesaver} < 1.1$	$.19 < r_i < .57$	$\alpha_{Timesaver} = .60$
Detail Oriented	$2.3 < M_{Detail} < 3.6$ $1.0 < SD_{Detail} < 1.3$	$.38 < r_i < .57$	$\alpha_{Detail} = .70$
Skill Developer	$3.3 < M_{Skill} < 4.1$ $1.2 < SD_{Skill} < 0.9$	$.18 < r_i < .47$	$\alpha_{Skill} = .61$
Socialite	$2.7 < M_{Socialite} < 4.5$ $0.8 < SD_{Socialite} < 1.1$	$.42 < r_i < .62$	$\alpha_{Socialite} = .74$
Explorer	$2.4 < M_{Explorer} < 3.4$ $0.9 < SD_{Explorer} < 1.2$	$.34 < r_i < .50$	$\alpha_{Explorer} = .67$
Independent Researcher	$2.4 < M_{Independent} < 3.8$ $1.0 < SD_{Independent} < 1.2$	$.24 < r_i < .52$	$\alpha_{Independent} = .63$
Mastery	$3.7 < M_{Mastery} < 4.4$ $0.7 < SD_{Mastery} < 0.9$	$.43 < r_i < .56$	$\alpha_{Mastery} = .74$

RQ2: Statistical Characteristics

	Time Saver	Detail Oriented	Skill Developer	Socialite	Explorer	Independent	Mastery
Time Saver	-						
Detail Oriented	.35**	-					
Skill Developer	.00	.17*	-				
Socialite	.22**	.16*	0.06	-			
Explorer	-.22**	-.12	.18*	-.01	-		
Independent	-.28**	-.25**	.21**	-.43**	.14	-	
Mastery	-.18*	-.05	.24**	-.09	.29**	.32**	-

*Correlation is significant at the 0.05 level (2-tailed).   **Correlation is significant at the 0.01 level (2-tailed).

RQ3: Student Subgroups

Methodology

Participants
- Recruited 157 participants in three universities of country of authors
- 52.8 % of the students were female
- Students referred to the last chemistry lab they participated in and they were asked how well they remembered the lab on a scale from 1 – 10.

$$\bar{X} = 8.1 \pm 2.0$$

Data Analysis
RQ1: Calculated item means, item discriminations, and Cronbach's Alpha
RQ2: Correlation Matrix
RQ3: Latent Profile Analysis

Preliminary Conclusions and Implications

➤ Latent Profile Analysis seems to confirm some of the conclusions from the original Phenomenographic study:

➤ Perspectives on level 4 correlated with each other and not with perspectives lower in level

➤ Correlations of skill developer with level 4 and 3 perspectives may suggest that the perspectives may be hierarchically inclusive

➤ *We envision this questionnaire can be used to study student perspective profile in the laboratory before and after implementation of a reformed curriculum*

References

1. Bodner, G. M., & Orgill, M. (2007). Theoretical Frameworks for Research in Chemistry. *Science Education*.Collins,
2. A., Brown, J. S., and Holum, A. (1991). "Cognitive apprenticeship: Making thinking visible." *American educator*, 15(3), 6-11..
3. Reid, N., & Shah, I. (2007). The role of laboratory work in university chemistry. *Chemistry Education Research and Practice*, 8(2), 172-185.
4. Baumstark, A., & Henary, M. (2010). Chemistry 3110 Lab Manual. Atlanta: Georgia State University.
5. NVivo qualitative data analysis software; QSR International Pty Ltd. Version 10, 2012.
6. Rubin, H. J., & Rubin, I. (2005). Qualitative interviewing: the art of hearing data (2nd ed.). Thousand Oaks, Calif.: Sage Publications.