Measuring Interest During a Student Lab Visit: A Question of Situation or Disposition?

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Abstract

The need for tailored science education that highlights competencies, but also motivation and interest, is essential in an era of declining interest in STEM subjects. This study evaluates the dynamics of interest within a student lab as informal science learning environment, utilizing Krapp's person-object-conception of interest and the RIASEC+N-model of interest dimensions during science activities. We aim to assess how interest varies depending on the lab activity and detect the proportion of interest attributed to personal disposition versus situational elements during typical lab exercises. Implementing a single day experience sampling methodology, we measure interest in real-time during lab activities, mapping them to the RIASEC+N-model. Initial findings from a study involving 420 German secondary school students suggest that individual interest in chemistry significantly influences situational interest during activities. Variance decomposition based on a latent state-trait analysis indicates that individual interest dominates over situational interest components during activities. Future work aims to refine the latent state-trait model and to identify learning environment characteristics impacting the situational characteristics of interest. This might contribute to the development of more inclusive and effective student laboratory programs and a move away from the 'one-size-fits-all' approach in informal science education.

Subject and Problem

At a time when media and daily life progressively engage with STEM topics, a more tailored approach to scientific education is necessary, as a 'one-size-fits-all' strategy gradually proves to be unsuitable for the diversity of learners (Getty, et al., 2021; van Vorst & Aydogmus, 2021). Not only complexity, content, and competencies are concerned, but also interest and motivation since these are key elements for lifelong learning (NRC, 2015).
At the same time, interest in STEM subjects declines among students as they progress through their academic years (Köller et al., 2020), making it essential to explore innovative approaches that can maintain or reignite their enthusiasm in this field. An example for this attempt are informal learning environments like student labs, that emerge as powerful platforms where students can engage with scientific issues in an experimental, hands-on manner (Guderian & Priemer, 2008). This way motivational and affective features of students can be promoted (Tillmann & Wegner, 2021), leading to a deeper connection with scientific disciplines (Ainley et al., 2002). However, to ensure the effectiveness of such approaches for a diverse group of learners, there is a need to deepen our understanding of the complex dynamics of interest underlying these learning environments.
Krapp's person-object-conception of interest (1992; 1998) provides a suitable framework for the research objective of this study. Interest as a relationship between a person and an object of focus can be characterized as both situational and individual.

Situational interest is a current psychological state influenced by external factors, such as an activity or learning task. This multifaceted construct may comprise emotional, value-related, and epistemic valence attributions. Individual interest, on the other hand, is considered a rather stable individual disposition that is primarily (but not exclusively) internally driven (Alberts et al., 2022). These sub-constructs of interest are not mutually exclusive but interact with each other in form of trait-state interest dynamics (Su et al., 2019). The object of focus can take various forms, such as a tangible object, an idea, or an activity. When assessing the interestingness of a science learning environment, students often place more emphasis on the form of activities than on their content topic (Swarat et al., 2012). However, activity forms often remain unconsidered in the research on STEM interest structures (Blankenburg & Scheersoi, 2018). They are therefore addressed by the RIASEC+N- model of interest dimensions during science activities (Dierks et al., 2016) (see Fig. 1). In our study, we aim to investigate the type of interest predominantly experienced by students during typical lab activities. Our measurements place a distinct emphasis on the emotional valence of situational interest. We chose this focus due to microinvasive assessment of the affective component of the construct compared to the residual valences. This immediate ranking possibility is valuable in understanding how different elements of the learning experience may foster or inhibit interest in the moment. Given that Pekrun (2006) differentiates achievement emotions into trait and state types, this distinction aligns well with our research objectives. These considerations lead to the following research questions:

RQ1: How does the emotional valence of situational interest vary between high trait-interest and low trait-interest groups, depending on the specific student lab activity?

RQ2: What proportion of interest can be attributed to disposition (trait) versus situation (state) during typical lab activities?

The outcomes of this research will be instrumental in determining whether a more personalized approach, considering individual learners' predispositions, is required for designing effective learning environments.

Research Design

In RIASEC+N-based studies, the trait component of interest in activities is measured using questionnaires (Höft & Bernholt, 2019) without actually having students carry out the activities. However, the latter is necessary to measure the state component and requires a study design in which interest is captured in real time after respective activity. To fulfill this, we adopt a single day experience sampling methodology (Csikszentmihalyi & Larson, 2014) where measurements of interest are spread over a six-hour laboratory session. The measurements are mapped to typical scientific activities derived from the RIASEC+N model. Considering the iterative nature of our study and the need for minimally invasive measurements (Rotgans & Schmidt, 2018), we employ short scales for interest and motivational cost (Wilde et al., 2009) as well as cognitive load (Schwamborn et al., 2011). Students rate their responses on a five- or seven-point unipolar Likert scale ranging from “not true at all” to “completely true”. We administer these surveys via tablet for efficient data collection.

The survey is integrated into a student lab program centered on the topic of ocean acidification which was specifically designed to accommodate for this study. The program includes examples of all RIASEC+N activities which are considered typical lab tasks for students to rank. Data collection is divided into three testing blocks including a trait questionnaire and seven situational measurement situations plus an overall program ranking. An overview of the measurement distribution during the lab program is depicted in figure 1.

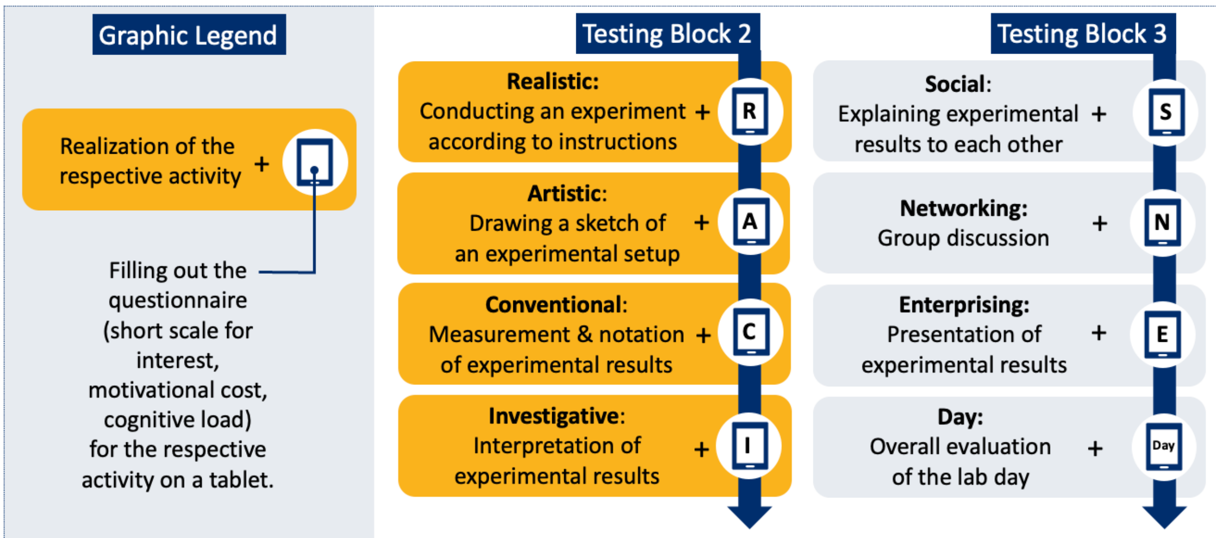

Figure 1: Distribution of the situational measurements in testing block 2 and 3 with the description of the exemplary RIASEC+N activities (Dierks et al., 2016) implemented in the laboratory program. Testing block 1 consists of a trait information questionnaire preceding the laboratory program.

Following a theoretical introduction, we initiate the first survey block, collecting demographic data (age, gender, last chemistry grade) and assess individual learning dispositions, such as individual interest, self-concept, perceived self-efficacy, extrinsic and intrinsic learning motivation, expectancy of success for the lab day, and perception of motivational costs. This information enables group division for between-group comparisons and supplements the analysis of individual influences within the latent state-trait approach. Following the first block, students proceed to the lab for the second survey part.

Here, they perform the RIASEC+N activities *Realistic, Artistic, Conventional,* and *Investigative* successively after moderation of the researcher. After each activity, students evaluate their experience using the short scales immediately. The analogous third testing block with the activities *Social, Enterprising* and *Networking* is in the subsequent debriefing.

The repeated measurement design allows for a latent state-trait analysis based on structural equation modeling (Steyer et al., 1999). This seems appropriate as the conceptualization of interest underlying our study also relies on state-like and trait-like interest concepts. The analysis allows us to distinguish between situation-specific variance and cross-situational variance in repeated measures of the same construct (Geiser et al., 2013), thereby providing an insight in the dynamics of student interest during the lab day.

Findings and Analysis

The study included 420 secondary school students (*M* = 15.1, *SD* = .92) from southern Germany. The gender distribution of the sample was approximately balanced (48.3% female, 47.4% male, 3.3% identifying as diverse). In terms of school location, a majority of the participants (62%) attended schools in rural or suburban areas, while 38% were from urban locations.

RQ1: The most favored activity is *Realistic* (conducting an experiment according to instructions, *M* = 3.99, *SD* = .87), while phase *Investigative* (interpretation of experimental results) is the least popular (*M* = 2.78, *SD* = 1.10). An ANOVA with repeated measurement shows highly significant differences between chronologically successive phases ($p < .001$), with exceptions for shifts from activity *Artistic* to *Conventional* and from *Social* to *Enterprising* ($p = 1.00$ according to the Bonferroni-Post-Hoc-Test).

For between-group comparisons (extreme group analysis) the sample was divided into five quantiles according to the regarded variable like individual interest in chemistry (data from testing block 1).

The marginal quantiles were used to form the high and low extreme groups. The participants in between were combined into a medium group.

The activities labeled *Realistic* and *Artistic* were more popular among girls than boys ($p <.001$). High trait-interest students had greater interest in all RIASEC+N activities than low trait-interest students, with statistically significant differences in all phases except *Realistic* (see Fig. 2). The variances in interest perception, as seen based on the interquartile range of the boxplots, indicate that dispositional differences play a crucial role in activity ranking. High correlations were found between intrinsic motivation and interest in chemistry ($\rho = .72^{**}$), self-concept in chemistry and self-efficacy perception in chemistry ($\rho = .73^{**}$), and self-concept in chemistry and interest in chemistry ($\rho = .66^{**}$). Negative correlations exist between self-concept in chemistry and last chemistry grade ($\rho = -.54^{**}$), and motivational costs and interest ($\rho = -.64^{**}$).

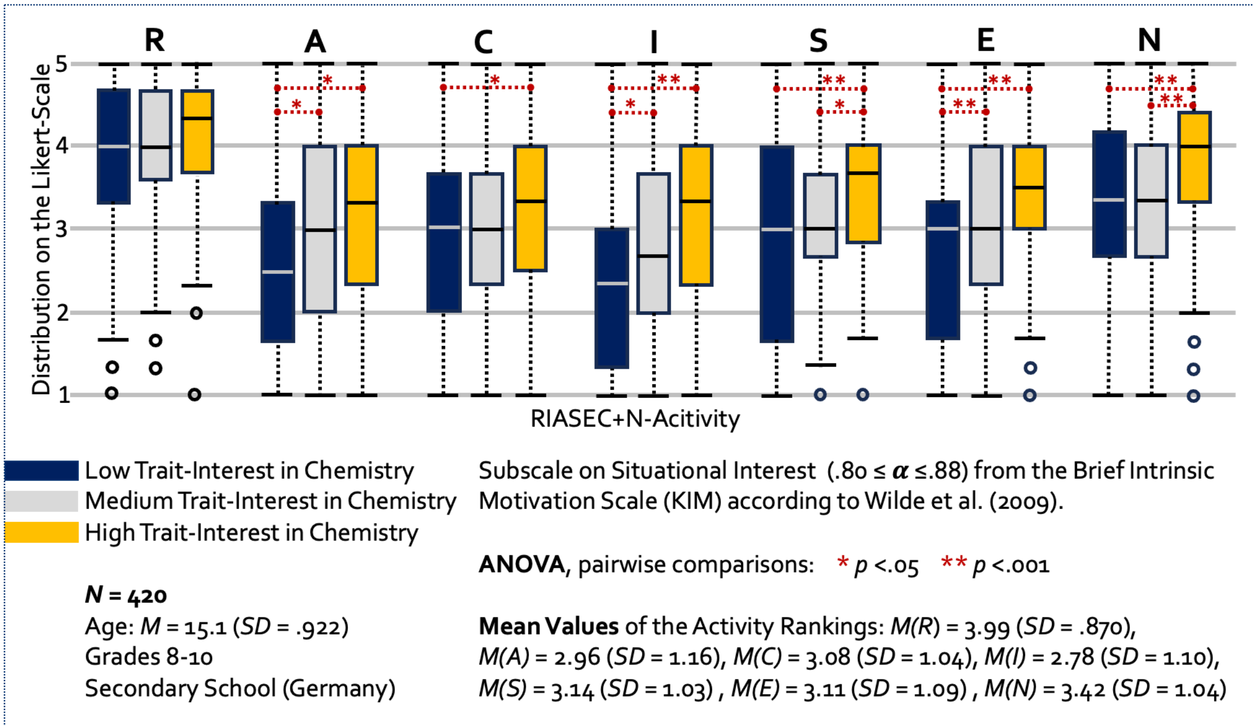

Figure 2: Boxplots of the distribution of Interest during RIASEC+N activities as a between-group-comparison of students with high, medium, and low interest in chemistry. The sequence of the phases in the diagram corresponds with the data collection order during the lab program.

RQ2: Latent state-trait theory, an extension of classical test theory (Geiser et al., 2013; Kelava et al., 2020), separates observed test values into the value of person-specific influence on the measurement (latent trait variable) and the influence of situation or person-situation interaction, alongside the measurement error. A multistate-singletrait model with assumption of equivalence and free estimation of variances was applied, using R with the lavaan package for latent state-trait analysis. The factor loadings were fixed to 1 as standardization, making the coefficients used for the variance decomposition interpretable. The measurement error variances were defined as independent of each other but equal within the same phase since they are measuring the same construct. The model was limited to the second testing block (phases *R, A, C, I*) for better computability, in assumption of the phases to be correlated. The LST-model is depicted in figure 3. The fit of the suggested model was tested by means of a confirmatory factor analysis. Since the chi-square test is sensitive to sample size and complexity (Schermelleh-Engel et al., 2003), the focus is placed on the indices with more practical relevance. With a CFI as well as TLI of .95 and RMSEA of .07 the model fit is considered acceptable. A variance decomposition was performed to break down situational and dispositional components by separating variance into a situation-specific and cross-situational proportion. The consistency coefficient Con (amount of variance explained by trait) and specificity coefficient Spe (amount of variance explained by state) were calculated and compared for each phase. In all four phases Con is higher than Spe, particularly in phase *Realistic* with a value of 0.7 compared to an average of 0,6 in the residual phases. This indicates that during the activities the proportion of individual interest dominates over the situational interest component. The specificity coefficient in phase *Realistic* had a negative value close to zero, suggesting no influence by the situation at all. Potentially the value could be an artifact of the measurement process itself, suggesting that caution is required when interpreting this outcome.

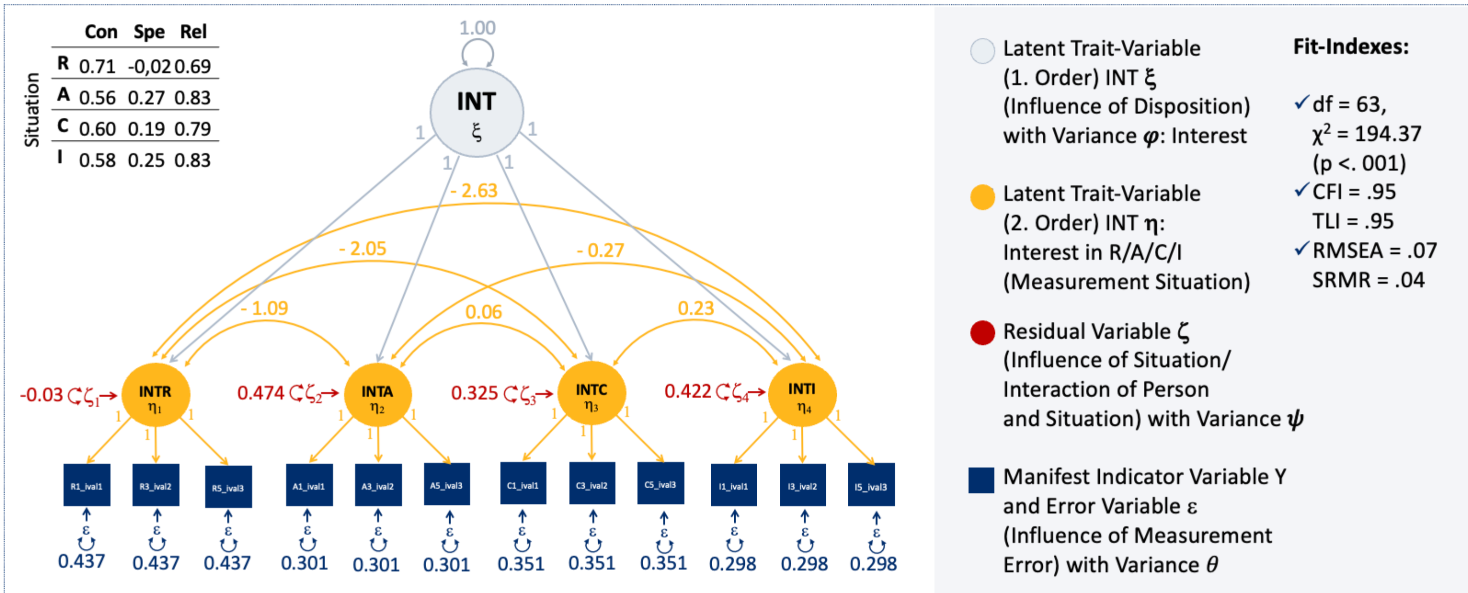

Figure 3: Latent state-trait model for the survey phases *R, A, C, I* with model fit indexes and consistency-/ specificity-coefficients.

Discussion and Implications

RQ1: The interquartile range of the boxplots suggests a dispositional influence on ranking situations. If the situational influence was dominant, we would expect to see more narrow ranges. Wider boxes may also hint at the ambiguity of the ranking situation. The lack of chronological order in the decline of mean values for activity rankings suggests the transfer effects are implausible. We confirmed the literature-derived assumption that individual interest influences situational interest (e.g., Habig et al., 2018; Renninger & Hidi, 2011; Rotgans & Schmidt, 2018) during the activities.

RQ2: The high coefficient value in phase *R* may suggest a stronger integration of dispositional preconditions during initial ranking as there are no other ranking situations for comparison at this point. From phase *A* onwards, the situational influence becomes more significant, reflected by higher Spe-coefficients. Contrary to the suggestion of Knogler et al. (2015) that the Spe- and Con-coefficient ratio depends on the homogeneity or heterogeneity of activities the repeated measurements are linked to, in our study we found different results. Despite our activity setting being considered heterogeneous, our findings contradict their proposition that the situational variance is lower in homogeneous settings and higher in heterogeneous ones.

Limitations: The data was gathered through self-report measurement. The novelty effect or hands-on engagement in phase *Realistic* could have influenced the measurements, possibly explaining the coefficient peak compared to other phases. Sequential or positional effects on ranking situations could have occurred as they were conducted in chronological order, leading to carry-over effects. The negative variance value in phase *R* could originate from the fit of the model.

Next steps: A follow-up study is underway to address the effects mentioned in the limitations section. The research aims include identifying characteristics of a learning environment that could influence the state-proportion of variance in measurements. For short-scale validation, we are expanding the study to a mixed-methods approach with semi-structured, focused interviews reflecting the phases *RACI*. The latent state-trait model is set to be improved and expanded, supplementing individual interest in chemistry among other dispositional variables from the trait information questionnaire as exogenous latent variables. Implications for the design of future student lab programs will be recommended based on the data from the follow-up study and interviews. For instance, interest-based internal differentiation could serve as a promising starting point (Güth & van Vorst, 2024) to make science education more inclusive, moving away from the 'one-size-fits-all' approach.

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