Why Do Students Fail in Formal Reasoning?
Steps to Broadening the Explanatory Perspective

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Abstract

We face a growing level of heterogeneity in Students level of ability to understand formal knowledge, to follow formal reasoning und ability to understand formal languages, e.g. the language of mathematics, programming languages or logic calculi. Our overall question is: What is the way to help the – say – weakest group of the students? Closely connected to this question is the question: "What prevents those students to understand?".

We suggest to approach these questions in the spirit of constructivism and get away off viewing the student behavior (like: "passivity", "problems in following formal reasoning" etc.) as deficits. We suggest to view it as meaningful reactions to their environment. We show how this approach leads us to gain more insight into possible solutions. And dependent on which environment (i.e. the student and its peer students; the student and its family of origin; the student and the university system) we focus, we show how to gain different parts of the puzzle and different answers to the question on how to support the student. More precisely, if we consider the student in the system with its peers, and if we appreciate the influences of the peer group on a student, we could suggest techniques like "pair-programming"-based exercises or techniques to intercommunicate with peers on the learning process. If we consider the student in the system of its family of origin, we could appreciate the fact, the process of individuation against the family of origin is connected to the process of individuation in formal thinking which again is a prerequisite for academic success. This claim is supported by the philosophical system of Ludwig Wittgenstein. If we claim, that better individuation leads to greater academic success then we have to support students in individuation. Finally, if we consider the student in the system with the university then we come to suggestions like strengthening the didactical concept of the university and development of mission statements how to approach didactics.

1. The Complex of Students' Problems in Following Formal Reasoning

The university system in Germany is in the middle of a process of opening, i.e. broadening the target group and decreasing the requirements for application at a university. Due to this process we face a growing heterogeneity in the skills of students of specific cohorts which becomes probably most apparent in STEM-disciplines, i.e. in science, technology, engineering, mathematics and computer science. Especially the gap between the "lower" (with respect to academic skills) third and the "top" third increases. Consequently, the pressure on the lower third increases and we observe a complex of critical behaviour and attitudes including "passivity", "procrastination", "low academic self-confidence", "low self-esteem", "refuse to identify with the academic field", "lack of interest in the subjects of the studies" and so on. On the other hand, we observe a complex of critical behaviour and attitudes on the "other side", i.e. on the side of professors, lecturers, tutors and academic staff reflected by statements like: "those students are lazy", "the intelligence of those students is just not sufficient" / "the academic predisposition of those students does not fit the requirements of academic studies". Usually, the aforementioned attitudes, even when stated in a more pleasant way, lead to approaches like introducing obligatory tutorial courses (to mitigate the students' laziness) or lowering the complexity of the taught topics (to mitigate the students' academic inabilities).

2. Goals and Explanatory Approach

We think, however, that both aforementioned "solutions" are themselves part of the overall problem. The explanations these solutions are based on could be named (according to [1]) "dormitive": The observations are more or less renamed and defined as a cause. This can be seen as a step to define a stop in explaining a phenomenon at an early point in the causal net and if we want to go deeper down the explanatory ladder, we should give up this and assume, that the problematic behaviour is meaningful and sound. It is generally a hint that our view is too narrow – or, in other words, that we do

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not consider the whole system – if a sound interpretion seems impossible. In cybernetic theory, systems are not influenced by an external cause but by immanent circular self-stabilising processes and a narrow perspective does not take into account the whole causal process.
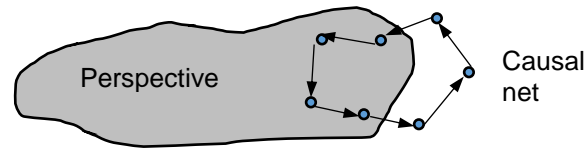

Fig 1: Narrow explanatory perspective and a causal net.

The overall goal is to help the weak third of the students. Which form the help should have can be deduced by the explanations we get from broadening our perspective. We suggest three dimensions to do this:

- The student in the system with his peers.
- The student in the system with his family of origin
- The student in the system of university professors, the university regulations and governance.

3. The student in the system with his peers

Reflecting the taught subjects, the competences and reflecting the process of studying should be put as discourse between students. It is a common observation that specially weak students tend to refuse verbalising these matters. It's a mistake to just put students' passivity as a cause for that; we should also put students' lack of verbalisation as a cause for passivity. Consequently, we have to search for didactical approaches which provoke reflection and verbalisation about both the taught subjects and the study as a whole and break the causal circle (passivity causes non-verbalisation causes passivity, etc).

3.1 Pair-Programming-style exercises

The technique of Pair-Programming [2] is well known in Software Engineering and stems from the agile methodology. It prescribes in detail the way programmers work on their code. In fact it can be shown, that the act of designing software code becomes more effective when two programmers work on it at the same time on the same computer. One programmer plays the active role, writes the code, verbalises and explains his thoughts. The other programmer tries to understand and asks technical questions; he is forbidden to make suggestions or question the others approach. The roles are changed regularly. This setting can be applied not just on programming but on many practical exercises where solutions have to be developed in a creative way. However, an intensive supervision is necessary at the beginning since it shows that particularly for weak students it seems unfamiliar to to take the active role on the one hand and listen to what a peer does on the other hand and to hold the "tension" of pair-programming for an efficient amount of time.

3.2 Learning Logs

We made good experience in the following technique as an exercise in self-reflection and verbalisation. We required – as part of the tested examination – a learning log from each student. After each lesson, the students should add a log-entry describing their individual feelings, problems and approach to the taught material and reflections about their learning process. We could see that this writing and reflections process alone lead to the higher self-esteem, more activity and a clearer learning approach.

4. The student in the system with his family of origin

The academic success is closely connected to the trust the student has in his own reasoning and his own intellectual potential and the willingness to start out into the lonely world of thinking without immediate feedback. Our hypothesis is that this does not work in many cases solely because the necessary steps of individuation have not been run through. And any individuation bases on the individuation against the family of origin. An example is a student visiting my office for inspecting his exam which he did not pass. After leaving my office he came back again after a few minutes with the question if I would allow him to take a photo of the exam as a proof to his father that he nearly passed it. A great part of his motivation to study was obviously a parental mission.

4.1 Psychological Approaches

We organised a course entitled "Learn to Learn" together with specialists from the german association of systemic pedagogics. This course comprised exercises in individuation, reflection of parental missions and how these interfere with one's own motivation and exercises in problem solution and questioning. We made good experiences with this course although it showed to be difficult to integrate it in the curriculum and questions remain: How can the competences be tested? Should it be a proper course with ECTS or just an additional offer? When it is just additional, we found it difficult to approach the students showing the "problematic" behaviour (passivity).

4.2 Philosophical Approach due to Wittgenstein

We engaged a philosopher who is a specialist in Wittgensteins philosophy practicing his knowledge to help people cope with various problems especially problems in individuation or problems in leading an active live. Ludwig Wittgenstein reflected the meaning of language and many of Wittgensteins considerations are connected to foundations in understanding formal languages and formal reasoning. Specially his later work, the philosophical investigations, should seems to be relevant for our considerations. He points out that "Die Bedeutung eines Wortes ist sein Gebrauch in der Sprache." [3] which can be translated as „The meaning of a word is its use in the language". Wittgenstein presents deep reflections on what this means regarding the use and the associated way to follow specific rules. Wittgenstein's language games, for instance, could be applied to students in order to reflect their way to follow these rules.

4.3 Student Success with NLP

We think that the NLP-approaches could be worth considering as a tool to help enforce individuation processes and break behavioral patterns connected to enmeshment with parental mission, family of origin beliefs and lack of individuation against the family of origin and possibly against peer groups.

5. The student in the system of university professors, the university regulations and governance.

The system of the university as an organization influences the way students are treated, students' failure is handled and even the way professors approach students' weaknesses and the way students are esteemed and the level of being on a par with students. Therefore, we think that this system is probably the most relevant and the – at least theoretically – most adaptable. Both aforementioned unproductive explanations for the unpleasant student behavior (i.e. laziness and lack of ability/talent) may also be reflected in examination regulations, mission statement and in the way professors teach. In the following, we sketch regulations and organizational characteristics of universities which adhere to deeper explanations:

- No enforcement to register to examinations. Students should be able to arrange their courses and examinations as freely as possible,
- possibility of more than 3 attempts for each examination,
- as little regulations as possible where students have to justify,
- as little repression as possible regarding the course of study,
- enliven the discourse among professors / teachers how to approach students, how the approach students' weaknesses and how to appreciate students, [4]
- enliven the discourse among professors how to communicate on par with students,
- anonymization of examinations wherever possible.

6. Conclusion

Why do Students fail in formal reasoning? Broadening the explanatory perspective brings new insight on supportive action for students, especially for the weakest third of a cohort. The aforementioned reflections and techniques bring. (i) Better quality in communication, (ii) Better integration especially of the weak students in the university environment, (iii) Explication of the decision to study and the field of interest, (iv) Growing intellectual self-esteem, (v) Perturbation of "bad" learning habits.

References

[1]   Gregory Bateson, "Steps to an ecology of mind", University of Chicago press, page 5.

[2]   Kent Beck: "Extreme Programming Explained. Embrace Change.", Addison-Wesley Longman, Amsterdam 2004, Page 58

[3]   Ludwig Wittgenstein, "Philosophische Untersuchungen", Paragraph 43.

[4]   Rolf Arnold: "Bildung nach Bologna", Springer VS, ISBN-13: 978-3658089771