# Soft Skill Development along the Education Path

## Evaluating expectations on and perceptions of student competencies in Software Engineering education

V. Thurner, A. Böttcher and V. Winter
Munich University of Applied Sciences, München, Germany

*Abstract—* In our everyday teaching we experience that many first-year students are ill prepared for the demands of an academic study process in technical domains. Usually, the students' problems are not rooted in a lack of intellectual capacity or previously acquired founding expertise in the chosen course of study. Rather, it is the deficiencies in more basic competencies such as practical and cognitive, self and social areas that place a major hurdle in the students' learning process. In an attempt to elucidate and improve this situation, as a first step we develop a questionnaire that captures the high school teachers' as well as the lecturers' expectations on student competencies in these areas, as opposed to their perception of competencies that first-year students possess in reality. This questionnaire is also applied to capture the university-employer skill gap.

*Index Terms—* soft skill competencies; self competencies; social competencies; practical and learning competencies; competence tests; introductory skill and competence levels; skill gap

## I. MOTIVATION

Every fall, an amazingly large number of young people surges into our universities for their first time, hopefully anticipating an increase both in knowledge and, later on, in pay. They bring with themselves a certain amount of knowledge and other more fundamental competencies previously acquired in school, vocational training and, generally, life. In addition, they usually are equipped with lots of youthful energy, an astounding amount of fancy high end electronic equipment, and a general desire to successfully conquer the world and have fun all at the same time. The world is their oyster and they set forth to make and take the most of it.

Similarly, every fall we the lecturers face this buzzing new crowd, ready again to help them on in their eager efforts to reach the holy grail of knowledge.

However, a few weeks into the first term, a general wave of disenchantment can be sensed creeping through hallways, labs and lecture rooms. At this stage, a certain percentage of students start to realize that their chosen course of studies, or even the process of studying itself, tends to be different from what they expected. Symptoms that can be observed more and more frequently at this stage are a general resignation when viewing the amount of work to be done, an increasing helplessness in the face of lab session assignments and even a tendency to cheat when due dates approach faster than enlightenment.

From the lecturers' perspective, in most cases the root of the problem is not mainly the complexity of the content to be learned, as most students expect subjects to be more sophisticated than they were at school. Rather, it is a general lack in more basic skills, such as systematically reading an assignment paper that covers more than half a page of written text, asking questions (other than "Is this relevant for the final exam?") to clarify any item that has not been clearly understood, or self-critically accepting constructive feedback and improvement suggestions on any assignments that have not earned perfect grades.

As well, at the risk of being over-demanding, we the lecturers would be happy to find in our students some other competencies as well, which we classify as being even more basic than the ones mentioned so far, although at first sight they have nothing whatsoever to do with learning either Java or technical mechanics. One of them is being on time, even if the lecture is scheduled for 08:15 on Monday mornings. Another good one would be to incorporate some sort of salutatory address into an email addressed to a lecturer, as well as some closing formula from which the name of the mail's originator becomes evident; not to mention the avoidance of email-aliases that are so obscene that they cause recipients to blush to the roots of their hair.

Our gut feeling, based on long years of experience in industry related work, teaching and parenthood alike, tells us that certain rudimentary competencies must be present both in a person itself and in the bottom layers of the human-to-human interaction protocol stack, before any higher levels of more complex interaction and other competencies can sensibly be attained. Obviously, a significant percentage of our incoming first-year students is not sufficiently blessed with these achievements when entering university. The causes for this situation are manifold and not within the immediate scope of our influence.

Of course we could take the position that it's not the universities' task to mend whatever has been lacking in our students previous education and upbringing, and get rid of these student groups as quickly as examination regulations permit. However, we find that the percentage of students with low basic skill levels increases continuously, while benchmarks of what can be expected move to a lower and lower level. Thus, if we want to live up to the mission that's been assigned to us from society, we have to attempt to pick incoming students up from wherever they are, and try to give them a fair chance to learn not only calculus and solid academic reasoning, but other more basic competencies to boot.

## II. RELATED WORK

The competence-driven view to curriculum issues has gained increasing attention during the last years. In Europe, the so-called Bologna Process aims at creating a convergence of higher education and thus requires all participating educational institutions to describe their teaching outcomes in terms of competencies. The set of competencies always includes non-technical competencies. For the area of software engineering only a relatively limited number of publications has dealt with analysis of competencies yet. Rivera-Ibarra et al. classified the relevant competencies into the categories "technical", "social" and "personal" [6]. Furthermore, they identified the required level of competencies according to different roles software engineers are playing within industry. The integration of soft skills into concrete courses and curricula was previously investigated by Brown et al. [3].

The industry perspective in terms of expected and required soft skills was substantially investigated by Bailey and Mitchell [1].

Most of the work mentioned is output-oriented from the point of view of a university, i.e. the effort concentrates on the needs of industry, e.g. [4,5]. The investigation of competency deficiencies in incoming students in the area of computer science, especially software engineering, is still lacking.

## III. IDENTIFYING COMPETENCE GAPS

To efficiently improve learning abilities in incoming students, we need to systematically gain an understanding of typical deficit profiles in our students' basic competencies. As a first step we focus on the school-to-university gap (Figure 1., left part, upper half) between skills that are expected in first-year students as opposed to those skill levels that are actually present in incoming students. On this basis, we can then try to develop educational paths and measurements that address specific deficiencies in an effective way.

While many of our students enter university directly after graduating from high school, a significant number has already completed some sort of a vocational training before entering university (Figure 1., left part, bottom half). So far, although we have included high school teachers in our study, we do not yet consider the supervisors engaged in vocational training. Their view on the apprentices' competence needs and development along the education path is subject of further research.

Obviously, the need for certain base competencies does not end when entering university. Rather, many of those skills become even more essential when entering the work force. To take this into account, we not only have to focus on the competency gap in incoming students at the transition from school or vocational training to university. Rather, we have to consider a potential competency gap in outgoing students as well (Figure 1., right part), since it is to be expected that employers find certain discrepancies in what they want from future employees and what they get from those university graduates that we bring on the market.
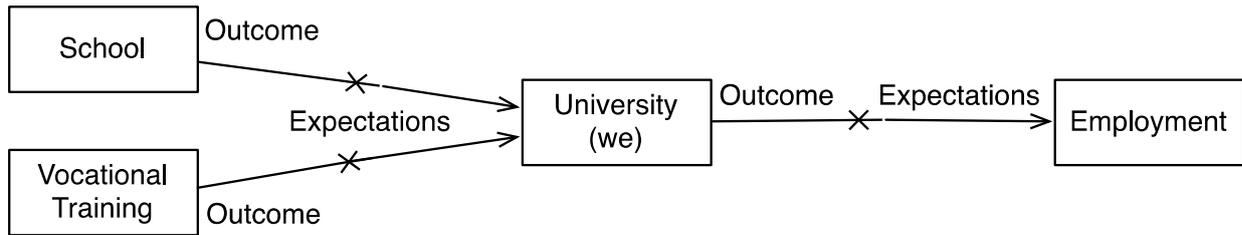
Figure 1. Competence gaps from school or vocational training via university to professional life

To make these issues more tangible, we developed a questionnaire that focuses on self, practical and cognitive as well as social competencies. This questionnaire we apply to capture both the school-university and the university-employer skill gap.

In the first case, we ask teachers to classify the respective skill levels of their graduates, as opposed to what teachers think that universities expect from incoming students. In addition, we question lecturers on the basic competencies they would expect in incoming students, as opposed to those skills that first-year students possess in reality.

Correspondingly, in the second case we ask employers about the basic competencies that they expect in job applicants, as opposed to what they actually find there. And again, we ask our lecturing colleagues about the skills our graduates acquired, in contrast to those competencies of which we lecturers think that employees will ask for. Any major discrepancies discovered here we should review in a self-critical way, as they reflect to what extent our produce (i.e. the graduate students) meets customer requirements!

To round things off we intend to include students into our survey. Therefore, we will ask the students' view on what basic competencies will be expected of them, as opposed to how they rate their own proficiency in these areas of competence. Again, this procedure may be applied to both incoming and outgoing students, thus focusing either the school-university or the university-employer skill gap.

## IV. COMPETENCIES IN FOCUS

Now, a crucial question is which are the essential competencies that we should focus upon. In our current attempt, we deliberately omit the area of technical competencies, as these are the central aspect of our teaching curricula anyway and have been investigated into in previous work [2]. Instead, we explicitly address
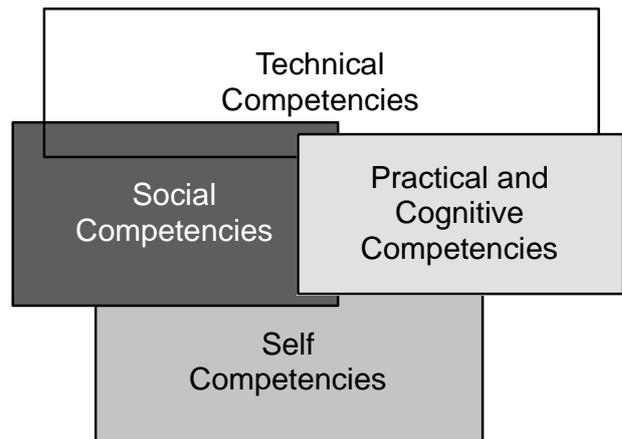


Figure 2. Competence stack

self, practical and cognitive as well as social competencies, as these form the basic requirements for successful learning and working processes and the acquisition of technical competencies (see Figure 2. ).

The relevant set of non-technical competencies is also investigated in [2]. For that work, we gathered feedback from software companies that are also potential employers for our graduates. They identified skills that they are looking for when interviewing applicants for jobs. Although not necessarily complete, this list seems to be a good starting point. As we are aware that this list is by no means all-embracing, we requested the addressees of our questionnaire to amend anything that they think is lacking.

### A. Self Competencies

Of the competence areas under consideration, self competencies are the most fundamental aspect, thus forming a basis for more sophisticated skills. They comprise a person's skills related to the perception of his or her own situation and needs, assuming responsibilities for one's own actions and reflecting on all of these aspects in a self-critical and constructive way. Among others, in our questionnaire we focus on the following aspects:

- Self-esteem without arrogance
- Ability of introspection
- Openness to constructive criticism
- Striving for life-long learning
- Motivation
- Dedication, hard and industrious work attitude
- Reliability
- Perseverance, resilience and flexibility
- Self-discipline
- Autonomy and self-reliance
- Willingness to assume personal responsibility
- High ethical values and moral courage

*B. Self Competencies*

This competence area comprises aspects such as basic methods of systematic working as well as other abilities that help to work effectively in a goal-oriented way. In its current version, our questionnaire covers the following aspects:

- Thinking in higher, superordinate structures
- Analytical, abstract and cross-linked thinking
- Systematic working and learning techniques
- Diligence and accurate work style
- Making pragmatic decisions, based on (intuitive) cost-benefit analysis
- Rhetorics, oratory and presentation proficiency
- Asking meaningful questions
- Word power and writing proficiency
- Reading skills, text and content analysis
- Time and self management
- Basic IT competencies, i.e. applying electronic equipment efficiently as appropriate tools in work and study processes
- Entrepreneurial thinking

*C. Social Competencies*

Last but not least, social competencies encapsulate whatever it takes to perceive and respect other people's needs and interests, and to interact and cooperate with others successfully and in a cooperative way. So far, our questionnaire deals with the following aspects:

- Empathy, understanding of others
- Listening skills and perception of others
- Tolerance and openness

- Civility and creation of a friendly atmosphere
- Esteem, respect and acceptance of others
- Ability to work and cooperate in a team
- Delegating work
- Accepting different working styles of others, and their results
- Assertiveness in balance with ability to compromise
- Constructive conflict management
- Strong communication proficiency
- Intercultural competencies

In the questionnaires, each of the competencies mentioned above should be rated on a scale from high (1) to none (5), for both the expected situation and reality, respectively. Verbally, ratings correspond to the following meaning:

(1) high
(2) moderate
(3) intermediate
(4) low
(5) none

Figure 6. and Figure 7. at the end of this paper show a translation of our questionnaire for lecturers on the competencies of incoming first year students. The questionnaires for teachers and employers were identical in their main content, differing only in the preliminary instructions.

## V. FIRST EXPERIENCES

Up to now, as a pilot phase to our survey we have addressed our questionnaires to selected lecturing colleagues, school teachers and employers in industry, asking them to comment on the concept in general and to fill in their estimates of expected and/or experienced skill levels. While lecturing colleagues and employers promptly provided the requested content and constructive feedback as well as declarations of lively interests in our work, we received only little response from the teachers' fraction so far.

Note that we have not yet included the students' view. This is due to the fact that we wanted to consolidate our survey first, before addressing a larger number of students in one go. We explicitly decided against including the students in our pilot phase as they are rather closely cross-linked. So we were afraid of setting the tongues wagging at the beta stage, thus

possibly spoiling the validity of results when things get serious.

So far, the number of completed questionnaires in each target group is too small to render meaningful statistical analyses in full detail. However, it is already possible to discover some general tendencies.

Figures 3 through 5 show the results for the respective expectations and perceptions for one of the competencies of each base competence area in the competence stack. Figure 3. focusses on learning and working techniques, as an example for practical and cognitive competencies. Figure 4. visualizes the development of self discipline as an instance of the area of self competencies. Finally, Figure 5. shows the ability to work and cooperate in a team, as a representative of social competencies.

In each of these figures, the first column indicates the school teachers' perception of their graduates' skill level in the competency under consideration. This is followed by the school teachers guess on what university lecturers, in their role of consumers of the school teachers' produce, would like to find in their incoming students. If school teachers educate their students with the intention of preparing them suitably for university, these guesses of the lecturers' requirements define some sort of skill level goals that should be achieved in school graduates.

However, in two of our three examples, the teachers' perception of their own produces' skills remains significantly behind these goals.

The third column visualizing lecturers' expectations is positioned immediately after the students' transition from school to university, and is followed by the lecturers' perception of the skill levels that incoming students possess in reality (fourth column). Although the lecturers' expectations appear to be rather moderate when compared to the teachers' guess, they are at least equal to or even higher than what the teachers perceive in their own graduates. Even more disillusioning is the fact that the lecturers' perception of students in reality attests them significantly lower skills than what the teachers thought that their graduates have.

During the course of their studies, university lecturers perceive a significant improvement of skills in their students.

At the transition from university to employment, we observe a similar, but somewhat less dramatic situation as at the transition from school to university. First of all, the lecturers seem to have a pretty much realistic idea of what employers are looking for in their future employees. However, although the goal is appropriately defined, lecturers do not succeed in reaching it in all areas under consideration. And again, the employers' perception of what skill levels they get in their new employees is lower
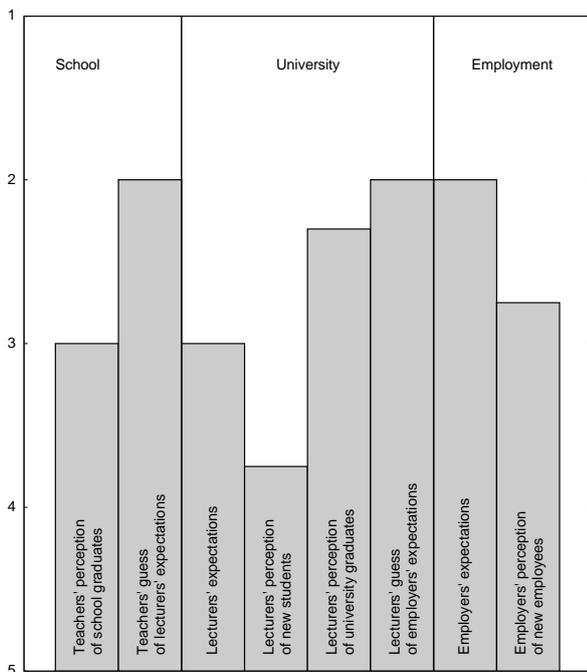


Figure 3.   Expectations and perceptions for the competency "Learning and working techniques".
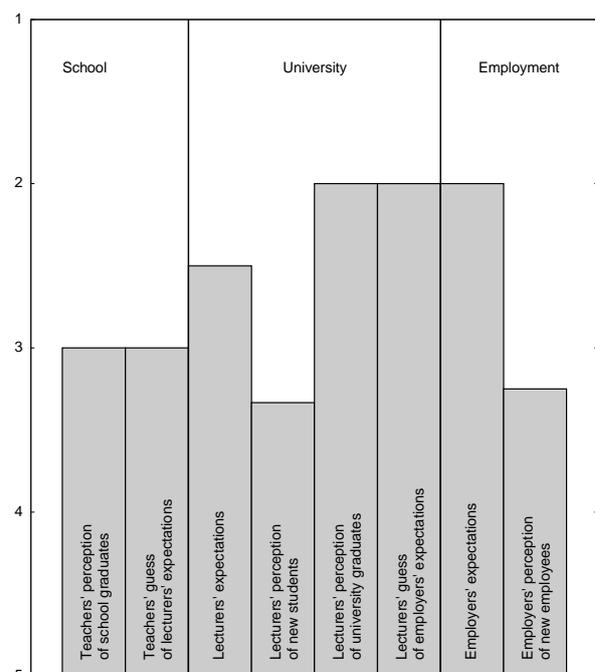


Figure 4.   Expectations and perceptions for the competency "Self discipline".

than what the producers (i.e. the lecturers) perceived in their own graduates.

So generally, the customers' perception of student competencies is generally lower than the producers' perception of his or her teaching outcome, which is rather embarrassing.

After examining one representative of each base competence area, we now summarize an overview of all the results within each competence area. Unsurprisingly, there is a general tendency to expect more than you can get, no matter whom you ask. More specifically, expectations are highest in the area of self competencies, with an average expectation value of about 2 for lecturers on incoming students and 1.5 to 2 for employers on applicants.

In reality, lecturers rank incoming student skills approximately an average 3, whereas employers attest the universities' output an average 2.5 in this area. (So this is some cause to celebrate, as it indicates that deep down at the bottom of the competency stack our students indeed improved measurably.)

Remarkably, employers' expectations ranked high ethical values and moral courage lower than any other competency in this area, whereas industriousness gained the relative low score among lecturers' expectations of incoming students. Both parties involved scored motivation and willingness to perform with highest expectations in this area, with a somewhat sobering

reality score of about two levels below expectations. Openness for constructive criticism was ranked high as well, with a discrepancy of 1 between expectations and reality.

Social skills are next on everybody's wish list. Whereas employers again request an average of a bit less than 2 from university graduates, lecturers are happy with an average of 2.5 in this area. In reality, both groups rate an average of approximately 3, where graduates show slight improvements in politeness, tolerance, openness and esteem of others, as compared with their younger fellow students.

Here, team and communication skills were of highest importance to employers, closely followed by politeness, tolerance and esteem. On the side of the lecturers, tolerance, politeness, understanding of others and listening skills were among the most highly ranked expectations. In contrast to this, both parties ranked assertiveness and intercultural competencies rather low, in expectations as well as in reality.

The least (and most diversely ranked) demands are addressed in the area of practical and cognitive competencies, where employers expect an average of about 2 and lecturers of almost 3. Both sides score reality rather low, with an average of more than 3 from the employers' point of view and almost 4 from the perspective of lecturers.

Here, lecturers and employers alike expect rather little in terms of entrepreneurial thinking and pragmatic decision taking, which corresponds to what either of them gets in reality. The greatest gaps in this area occur in writing proficiency, diligence and analytical thinking, where neither employers nor lecturers are satisfied with what they find in incoming work force or students, respectively.

## VI. LESSONS LEARNED

In addition to the requested rankings, our colleagues, industry contacts and the responding teacher liberally provided constructive feedback on our initial questionnaire.

While all of them were well able to define what they would like to have on the "Expectations" side, they unanimously had an issue with the "Reality" side. "By now, I've seen anything from 'gorgeous' to 'dreadful' in my applicants – so how shall I rate that?" commented one of our industry contacts, thus verbalizing a problem that most of our contacts addressed. So far, our pilot questionnaire requests only one "reality
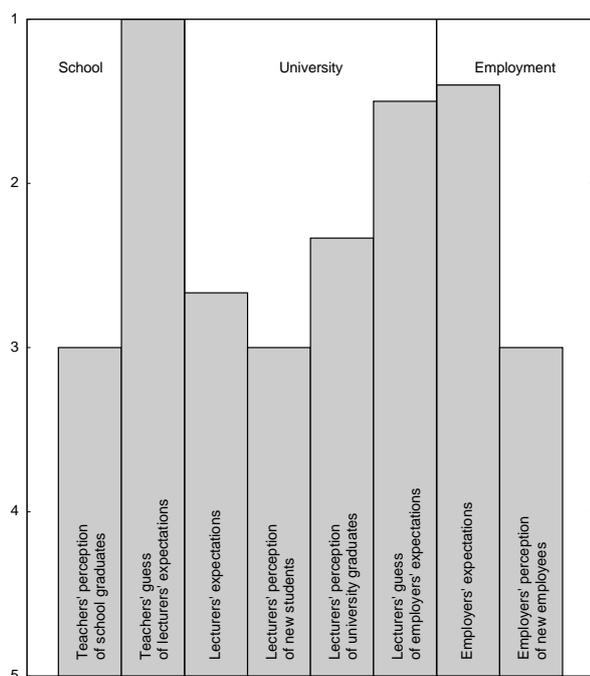


Figure 5.   Expectations and perceptions for the competency "Ability to work and cooperate in a team".

score" on each competency. Thus there is a certain risk that we get an estimated average value, which unsurprisingly tends to be located around 3 (intermediate). However, this does not reflect the distribution and mean variation of this skill level throughout the body of students.

We discussed several alternatives for dealing with this problem. One solution would be to mark each competency with a distribution of this skill level across the body of students, i.e. 10% level 1, 15% level 2, 30% level 3, 40% level 4 and 5% level 5. However, as these ratings are only a rough estimate from the perspective of the person that fills in the questionnaire, this method would pretend an accuracy that is not really present.

Another attempt would be to provide two reality rankings, one each for the top $n$% and the bottom $m$% of the student body, respectively, where adequate values for n and m are yet to be defined. This way, we would get an insight in the skill level difference between top level and bottom level students, but explicitly omit the middle range of the student body. As our main motivation for this work is the detection of typical deficit profiles at the "lower end" of the student body (and the subsequent development of corresponding instruction concepts that amend these deficits), we deem it feasible to omit the main part of the student body in our observations and focus on our low level target group instead.

We will test this approach in the next iteration of our questionnaire roll-out.

Furthermore, when discussing the launch of our questionnaire among our first year students we shared the reasonable suspicion that most of them would have certain difficulties in interpreting the competencies correctly, as our pilot questionnaire is somewhat taciturn and provides buzzwords rather than detailed descriptions of the competencies in focus. Thus we decided to modify the student version correspondingly.

Each competency is now reflected by one or more statements describing a certain situation, where the student is supposed to indicate how often this situation applies to him or her. For example, one of the statements addressing the competency of "openness to constructive criticism" is: "When somebody criticizes me, first of all I try to relate to this person why I did what I did in the way I did it." The student then indicates whether he or she acts (1) always, (2) of-ten, (3) sometimes, (4) seldom or (5) never as described in this statement.

## VII. CONCLUSIONS AND FURTHER WORK

To systematically understand the gap that gapes between what schools deliver in their graduates and what universities expect in their incoming first year students, we developed a questionnaire that captures differences in the area of self, practical and cognitive as well as social competencies. As a similar gap is to be expected at the transition from university to the work force, we analogously extend our investigation to the university-employer skill gap as well.

In an initial pilot phase, the survey validated the importance of self competencies as the foundation of more sophisticated skills in higher levels of the competency stack. As well, it confirmed our thesis of severe discrepancies in crucial competencies that exist between expectations and reality both in incoming and outgoing students as well as in all of the three competency areas we focused.

Based on the experience from our pilot phase, we will fine-tune our questionnaire by adding some competence aspects that have been underrepresented so far.

As a next step, we will include teachers and students into our investigation and role out our survey on a larger scale. At the end of winter term 2011/2012, all first year students of our faculty were presented with the student version of our questionnaire. Currently, we are still in the process of evaluating the data we gathered here. Thus we hope to gain qualitatively relevant insight into the different views on the competence and skill gaps, and back this up with a sufficient quantity to run detailed analyses on the gathered information.

Our long term goal in this attempt is to get a grip on deficiencies in basic soft skills in our incoming students. To achieve this, we want to identify typical deficiency profiles. For each of these deficiency profiles we then plan to develop educational measures that specifically address single deficiencies (or small sets of interrelated deficiencies) in fundamental base competencies, thus helping incoming students to improve their individual basis for successful learning and work processes.

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## AUTHORS

**V. Thurner and A. Böttcher** are Professors at Munich University of Applied Sciences, department of computer science and mathematics, teaching Software Engineering and related topics.

**V. Winter**.is also with Munich Universtity of Applied Sciences. She is working as a research assistant.

# PAPER

## SOFT SKILL DEVELOPMENT ALONG THE EDUCATION PATH

University of Applied Sciences Munich                                    Prof. Dr. Veronika Thurner

Faculty 07 for Computer Science and Mathematics                         Prof. Dr. Axel Böttcher

### Study Proficiency of First Year Students

This questionnaire deals with competencies that you *would like to already find* in incoming students, in order to be able to work with them effectively on your own teaching topics.

Please contrast your rating with those competence levels that incoming students possess *in reality*.

We focus on pracitcal and cognitive, self and social competencies.

Technical competencies are not a subject of this survey.

**Expectations**                                                                                   **Reality**

In incoming students, I expect the following                    In reality, incoming students have the following

competencies to this extent:                                        competencies to this extent:

Please mark your rating on a 5-point scale rating from "high" to "none".

| high | | | | none | Practical and Cognitive Competencies | high | | | | none |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| | | | | | Thinking in higher, superordinate structures | | | | | |
| | | | | | Analytical thinking | | | | | |
| | | | | | Abstract and cross-linked thinking | | | | | |
| | | | | | Systematic working | | | | | |
| | | | | | Diligence and accurate work style | | | | | |
| | | | | | Learning and working techniques | | | | | |
| | | | | | Making pragmatic decisions, based on (intuitive) cost-benefit analysis | | | | | |
| | | | | | Verbal language proficiency, rhetorics | | | | | |
| | | | | | Word power and writing proficiency | | | | | |
| | | | | | Basic IT competencies, i.e. applying electronic equipment efficiently as appropriate tools in work and study processes | | | | | |
| | | | | | Entrepreneurial thinking | | | | | |
| **high** | | | | **none** | **Other Practical and Cognitive Competencies** | **high** | | | | **none** |
| 1 | 2 | 3 | 4 | 5 | **(Please add anything you deem relevant )** | 1 | 2 | 3 | 4 | 5 |
| | | | | | | | | | | |
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Figure 6.   First page of our questionnaire for lecturers on the competencies of incoming first year students (translated from the German original)

University of Applied Sciences Munich

Faculty 07 for Computer Science and Mathematics

Prof. Dr. Veronika Thurner

Prof. Dr. Axel Böttcher

| high | | | | none | Self Competencies | high | | | | none |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| | | | | | Self-esteem without arrogance | | | | | |
| | | | | | Ability of introspection | | | | | |
| | | | | | Openness to constructive criticism | | | | | |
| | | | | | Striving for life-long learning | | | | | |
| | | | | | Motivation | | | | | |
| | | | | | Dedication | | | | | |
| | | | | | Willingness to perform | | | | | |
| | | | | | Industrious work attitude | | | | | |
| | | | | | Perseverance | | | | | |
| | | | | | Reliability | | | | | |
| | | | | | Flexibility | | | | | |
| | | | | | Resilience | | | | | |
| | | | | | Self-discipline | | | | | |
| | | | | | Autonomy and self-reliance | | | | | |
| | | | | | Willingness to assume personal responsibility | | | | | |
| | | | | | Moral courage | | | | | |
| | | | | | High ethical values as basic principle of one's own actions | | | | | |
| | | | | | Sense of responsibility | | | | | |

| high | | | | none | Other Self Competencies | high | | | | none |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | (Please add anything you deem relevant ) | 1 | 2 | 3 | 4 | 5 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

| high | | | | none | Social Competencies | high | | | | none |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| | | | | | Empathy, understanding of others | | | | | |
| | | | | | Listening skills and perception of others | | | | | |
| | | | | | Tolerance and openness | | | | | |
| | | | | | Civility and creation of a friendly atmosphere | | | | | |
| | | | | | Esteem, respect and acceptance of others | | | | | |
| | | | | | Ability to work and cooperate in a team | | | | | |
| | | | | | Ability to cooperate with others, delegate work and accept different working styles and their results | | | | | |
| | | | | | Assertiveness | | | | | |
| | | | | | Ability to compromise | | | | | |
| | | | | | Constructive conflict management | | | | | |
| | | | | | Strong communication proficiency | | | | | |
| | | | | | Intercultural competencies | | | | | |

| high | | | | none | Other Social Competencies | high | | | | none |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | (Please add anything you deem relevant ) | 1 | 2 | 3 | 4 | 5 |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Figure 7. Second page of our questionnaire questionnaire for lecturers on the competencies of incoming first year students (translated from the German original)