

Didactic Friction – challenges and reflections on interlinking PBL and discipline-specific tuition practices

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ABSTRACT

This is a discussion paper based on didactic reflections of three junior academics at the Architecture and Urban Design (A&UD) programme at Aalborg University. The discussion unfolds ‘didactic friction’, where principles of PBL come into contact with architectural didactics, causing challenging teaching situations. This discussion of didactic friction is moored in narratives representing typical student tuition, unfolding two situations where PBL and architectural didactics converge and cause friction: ‘the problem’ and ‘supervision’. This friction necessitates teachers and supervisors to critically reflect upon their teaching and supervision styles, and upon how key principles of PBL like ‘the problem’ is put into play in their discipline-specific tuition of students. The paper argues that teachers and supervisors have a heightened obligation and responsibility to monitor, assess, reflect and adjust the integration of the different teaching approaches in their tuition practices at A&UD.

INTRODUCTION

This paper explores what is termed ‘didactic friction’ in the Architecture and Urban Design (A&UD) tuition at Aalborg University in Denmark. During a teacher training programme at Aalborg University (AAU) in 2016, we, the authors, engaged in activities that prompted

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reflection upon didactics in relation to our own teaching practice. A reoccurring focus for our peer group discussions was our interaction with the students within the didactic framework of our specific discipline, while at the same time adhering to the AAU problem based learning (PBL) framework. Ideally all student tuition at AAU should happen within the PBL framework (Askehave, Linnemann Prehn, Pedersen, & Thorsø Pedersen, 2015), but in our tuition practice we often find ourselves in teaching situations where there seems to be a mis-match between the discipline specific didactic framework and the didactic framework offered by PBL. It is this mis-match we refer to as ‘didactic friction’, which will be unfolded in this paper. The research question that guides our inquiry is thus:

What didactic friction arises in the teaching practices in the A&UD programme as a result of the programme striving towards PBL in a cross-disciplinary didactic framework?

That A&UD employs a cross-disciplinary didactic framework for tuition is evident in the programme, positioning A&UD graduates as civil engineers in Architecture and in Urban Design, whom in their five years of study are introduced to and taught skills and competencies of engineering as well as architecture and urban design. In line with the cross-disciplinary approach that characterises the A&UD programme, the students should be able to synthesise functional, aesthetic, technical and environmental demands into excellent design (Kiib, 2004, p. 197-198). Being able to distinguish good solutions from bad requires knowledge and skills within both the architectural and the engineering field. A&UD students must therefore be able to master and comprehend the interconnectedness between these disciplines. Thus, A&UD is a civil engineering programme with a strong creative element, and in result the tuition focusses “on the interplay between the intuitive and the goal oriented aspects of university pedagogy” (Kiib, 2004, p. 204). Knudstrup supplements this position, saying that “artistic learning, the creation of ideas, and an ability to see new possibilities and be creative become just as important parameters as the ability to identify problems and suggest a rational solution” (2004, p. 222). Despite having a historical kinship, architecture and engineering are still two disciplines from widely different traditions that have approached student tuition in different ways. On top of this combinatory and cross-disciplinary approach to tuition, A&UD also integrates PBL principles into its tuition, and in this way, the A&UD programme seeks to combine and integrate a PBL framework with learning philosophies and accompanying institutionalised methods of teaching originating from the disciplines of architecture and engineering. In such a three way synthesis, neither approach exists in their traditional form, but are shaped and conform to each other. While there is surely upsides and great opportunities in this, we can also identify dissonances and potential incongruences that we suspect are the symptoms of fundamental differences inherent in these approaches. The intersections between didactics of PBL and of specific disciplines are the ones we in this paper refer to as ‘didactic friction’. Acknowledging that didactic friction might both cause positive and negative effects on the learning potential, it is relevant to note that in this paper we will focus on some of the *challenges* associated with didactic friction. It is also important to note that our intention with this paper is not to criticize

the current tuition at A&UD in general, but purely to highlight some of the challenges with didactic friction we meet in our teaching practice. Neither is it our belief that didactic friction disqualify integration of different disciplines and learning approaches in education. However, we do find it relevant to engender more awareness of didactic friction as an inherent phenomenon within PBL based educations, and hopefully with this paper we can lay tracks for developing initial directions for meaningfully handling these challenges. Finally, acknowledging that a comprehensive analysis of all possible didactic frictions between PBL and the sub-disciplines characterising the skills-oriented A&UD programme is beyond the scope of this paper, the analytical focus will be to explore possible didactic friction between PBL and architectural and urban design tuition only.

Before embarking on this quest, however, a didactic positioning is necessary, so that the following discussions of didactic friction can be evaluated in the same light as they are presented. Didactically this paper draws upon the ideas of fundamental interplay of instructional variables, as Duit (2015) present them, based on Heinmann, Otto & Schulz (1969). In this didactic tradition, the students' learning process is "of a key interest (and) the aims and intentions of instruction are the starting points for the process of designing instruction" (Duit, 2015, p. 326-327). Here the tuition process is shaped by four questions: why, what, how and by what, encapsulating the intentions of tuition, asking what the content is, what methods will be used and by which media tuition will happen. This didactic position mirrors the approach to tuition practiced (or aimed at) by the authors of this paper. At the same time the didactic understanding in this paper also includes Schön's (1983) reflections on tuition practice being an activity where constant adjustments are made in interactions with students. These constant corrections "happen in a dialogue with the situation, the material, or the people you work with. You always receive feedback from the situation, and the next step is taken in response to this feedback" (Laursen, 1997, p. 73, translated from Danish). These are the didactic positions that the following discussions of didactic friction are moored in.

Method

The endeavour to demonstrate didactic frictions is rooted in the authors' experience with tuition at the A&UD programmes as well as in inputs gained from the AAU teacher training course and peer group discussions. The data that underpin the analysis and discussion is in this paper represented through two hypothetical, yet exemplary and representative narratives that illustrate some of the challenges the authors have faced in the student-teacher tuition situation. These narratives are not to be understood as accurate representations of specific teaching situations. Instead we seek to evoke emphatic resonance and recognition that can catalyse discussion of didactic friction. Richardson (1994), Clough (2002) and Czarniawska (2015) advocate the use of narratives to convey experiences and insights from real life settings into academia. The paper has embraced this approach methodologically by grounding the narratives in our "versions" (Clough, 2002, p. 9) of tuition situations experienced at the Architecture and Design programme over the years, resulting in the narratives being "created as a result of our own interactions and intuitions" (Clough, 2002, p. 9). Aware that this approach does not fully comply with

more traditional ways of collecting and presenting data within the social sciences, we argue that by applying this evocative approach, the paper establishes and brings forward probable and recognisable learning situations as basis for future discussions of PBL tuition in the A&UD programme. The narrative approach is chosen in the acknowledgement that the authors, employed to teach and supervise in the A&UD programmes at undergraduate and postgraduate level, are not authorities on PBL, nor on university pedagogy. The contribution of this paper is thus to provide a modest view from practice, as input to the ongoing tuition development in PBL academia.

The remainder of the paper is structured as follows. Prior to jumping into the narratives of exemplary student-teacher tuition situations and zoom into the supervision practices, we will briefly provide some contextual information of the A&UD programme. Then, with a point of departure in the two narratives focusing on ‘the problem’ and on ‘the supervision style’, two key elements in the students’ project work and learning process, we unfold how different didactics intersect and cause friction. Lastly, we conclude with a discussion of the importance of discipline specific PBL, through highlighting three focus areas for turning didactic friction into a strength.

DIDACTIC FRICTION IN STUDENT TUITION

Since its founding in 1974 AAU has subscribed to PBL as the basis for student tuition (Holgaard, Ryberg, Stegeager, Stentoft, & Thomassen, 2015), and it remains a central and integrated part of the latest vision for AAU (AAU, 2015). The main AAU PBL principles include (based on Barge, 2010): problem orientation; project organization; integration of theory and practice; participant direction; team-based approach; and collaboration and feedback. How these PBL principles are operationalised in tuition at AAU varies greatly across the faculties and programmes. Kolmos, Holgaard and Dahl (2013) argue that the AAU-PBL tuition does not follow one specific model, but sees different programmes prioritise and subscribe to PBL in different ways. Drawing on Savin-Baden (2000) we might think of PBL not as a specific and well-defined method but rather as a philosophical approach to teaching and learning. She argues that PBL cannot be described by a set of narrowly defined characteristics but is an approach to learning that is “affected by the structural and pedagogical environment into which it is placed, in terms of the discipline or subject, the organization and the staff concerned” (Savin-Baden 2000, p. 19).

How PBL is implemented in practice can therefore vary. This is also the case at A&UD, where the semesters include a project module, supported by a number of course modules. In the project module student groups are given a specific design task (i.e. the design of an urban district, an office building, etc.) that provides an overall framework for the project both in terms of semester theme (e.g. Nordic architecture, tectonics, urban mobility etc.), geography, scope, theory, method and final output. According to the PBL principles of AAU, the research conducted by the students as part of their project module must take a point of departure in a

problem, which the students then have to analyse and suggest solutions to within the project module framework. The outcome of a project module is a report that typically comprises of two parts: 1) a design proposal responding to the specific semester theme and learning goals (text, diagrams, plans, sections, renderings of spatial qualities, etc.); and 2) description of and reflections upon the process of making the project, altogether demonstrating that the students at the end of the semester fulfil the given learning goals. The first part mimics the work practices of professionals in the field, e.g. in the case of developing a design proposal and visual material for an architectural competition. The second part constitutes the academic dimension, in which the students present and reflect upon how they have worked with and developed the project within broader analytical/methodological/theoretical frameworks which are part of the AAU PBL principles (Askehave et al., 2015). This bilateral task requires students to be able to manage and commute between these different foci, but also that the supervisor can adjust their tuition practice dynamically to the particular learning situation.

We experience that didactic friction between A&UD teaching traditions and PBL often occurs in relation to the students' understanding of the problem that is fundamental to their work associated with the project module, and to the role of the supervisor in this process. Thus the remainder of the paper will discuss didactic friction in relation to the *problem* and to *project supervision*.

The Problem as Didactic Friction

Supervision meeting with a student group at Architecture & Design: Midway in the project period the group has still not formulated its own problem formulation beyond the overall assignment statement in the project description. The group has been working a lot and they seem to agree on the direction of the project, but they have not prioritised spending time on formalising and communicating this. In an effort to incite this, Simon the supervisor asks directly into this: "Please explain to me, in as few words as possible, what it is that you are working with in this project, what is your problem formulation?". "Well, we haven't really tied down the problem formulation just yet, but we want to create an urban plan with focus on the inhabitant's everyday life...", one of the students begins, "... yes, but we also want to emphasise the waterfront. When we visited the site we saw it had some really nice recreational features" another adds. "I thought we agreed that the key thing was to create a place where it's easy to get from A to B, minimising wasted time in transport, because the project description says we've to work with an overall mobility strategy for the area ...", a third group member interjects. "Yeah, that's what I'm saying, focus on EVERYDAY life", the first student retorts. "Okay, wait a minute", Simon says, "I think you need to discuss what this project is about and from this you need to try do a problem formulation that you all agree upon." Simon spends a bit of time explaining why the problem formulation is

important to prioritise after which one of the student's replies: "Okay, we'll have it finished for you for the next meeting..."

This narrative calls attention to the function of the *problem* in the students' project work. At the heart of PBL is the pragmatic using of the problem as a tool in teaching and learning to focus attention, stimulate contemplation, facilitate inquiry and eventually expand knowledge and skill. Although we fully recognise that the problem within a PBL context does not have a singular and agreed upon definition, which Savin-Baden (2000, p. 16) also points to, in our experience the way it is generally portrayed at A&UD resonates with Barrows & Tamblyn's seminal definition of PBL as:

"[...] the learning that results from the process of working towards the understanding of a resolution of a problem. The problem is encountered first in the learning process" (Barrows & Tamblyn, 1980, p. 1)

This principle should be understood as a contrast to the traditional university learning approach in which memorising and one-way instruction of knowledge and skills are key methods for learning a subject or a discipline. Instead of simply 'transferring' knowledge to the students, the overarching gesture of PBL is to challenge the student to 'learn to learn' (Duch, Groh, & Allen, 2001). And in doing so, enabling the students to acquire problem-solving skills overshadow learning the body of knowledge in a particular field as the first move. Hence, "[t]he principal idea behind PBL is that the starting point for learning should be a problem, a query, or a puzzle, that the learner wishes and needs to solve" (Boud, 1985, p. 13). By equipping students with these skills, the base idea is to empower students to be able to solve complex problems themselves, and in doing so the students learn to identify, acquire and apply the relevant and needed knowledge. Thus, the *problem* in a PBL approach is an unavoidable keystone.

Hüttel and Gnaur (2017) point to that what they call 'project catalogues', predefined projects with predefined tasks, focus and scope the students can choose for their semester project, might inhibit the students' own process of analysing and developing their own problems. While at A&UD we do not employ project catalogues, we do, as explained above, provide students with project frameworks. What we find, and what is highlighted in the narrative, is that students sometimes merely adopt the provided project framework and bypass formulating their own problem. In these cases, the students are clearly not aware of the role of the problem in PBL. Surely, we do not have the material to claim that this is a widespread and general issues amongst all A&UD students. Rather we aim to emphasise that operationalisation of PBL in a particular education programme, in this case the A&UD programmes, is not necessarily frictionless as we zoom into the particular teaching encounters. As explained in the above section, the A&UD programmes seek to balance a PBL framework with didactics and teaching approaches from both engineering and architecture traditions on either side. When thinking about the problem

and the central role it plays in PBL, it is especially interesting to witness how the ‘master-and-apprentice’ learning system, often compared to “Studio Based Learning” (SBL) (Burroughs, Brocato, & Franz, 2009), from the architecture tradition position the problem. Here the problem is fundamentally understood differently from the PBL approach. If we look to the AAU PBL guidelines, the role of the problem is presented like this:

“The problem is the starting point directing the student’s learning process. A problem can be both theoretical and practical. It must also be authentic and scientifically based. ”Authenticity” implies that the problem is of relevance outside of academia. ”Scientifically based” implies that the problem is comprehensible and may be analysed and solved, taking an interdisciplinary approach” (Askehave et al., 2015, p. 4).

‘Authenticity’ in this context points to that education programmes should create project frameworks that are ‘true’ to the student’s future profession. This means, as Watson et al. highlights, that “[...] PBL is characterised by the use of real world problems as a context for students to learn critical thinking skills and problem solving skills and to acquire knowledge of the essential concepts of the course” (2004, p. 188). Here SBL and PBL integrate with each other unproblematically when addressing the authenticity of the problem in this way (Watson, Duch, Allen, & White, 2004; Burroughs et al., 2009). Indeed at A&UD, project frameworks in semester projects take point of departure in and revolve around resolving actual messy and often ‘wicked’ real-world problems, and the students’ project work is often loosely modelled to mimic the work practices of professionals in the field. Hence, the educational and structural setup around the student’s project work can in some regards be compared to participating in architectural competitions in professional architectural offices or engineering consultancies.

However, a key difference is that in PBL, while the project framework might be given, the actual ‘problem formulation’ within this framework is up to the students to develop. This should of course not be detached from the curriculum but should be situated within the project framework (or course framework) that in a ‘natural’ manner covers the curriculum designed by the teacher or coordinator. Consequently, the students should not start from scratch in defining their problem formulation but instead within this framework they must “[...] define the kernel of the problem” (Barrett & Moore, 2011, p. 18). This touches upon a second understanding of ‘authenticity’ of the problem in PBL, one that is absent in the SBL approach. It states that the problem cannot be strictly predefined and manufactured by the teacher to the last detail, but it must, as in the pragmatist understanding of inquiry and knowledge generation, stem from the students’ own genuine and qualitative wonder or puzzlement about something. This is a crucial condition. Dahl (2008) points to that PBL in project oriented work requires the students to be both creative and innovative, something which only can be cultivated if the student’s lack of understanding and knowledge of the problem is genuine (Dahl, 2008, p. 89). And so, in PBL a large effort goes into creating the conditions for a learning environment in which the

formulation of the problem is supported (i.e. through tuition). Consequently, the problem within PBL is a dynamic entity which is also emphasised in the PBL guidelines of AAU:

“A project represents a time-limited and targeted process in which a problem may be phrased, analysed and solved, resulting in a tangible product. A project report, for instance. The target of the project is determined in the problem formulation; like the project methods, this will be developed continually during the course of the project” (Askehave et al., 2015, p. 4).

This highlights an even more fundamental issue that might potentially cause friction between PBL and SBL approaches, i.e. the problem being, crudely depicted, respectively ‘dynamic’ or ‘static’. As such, SBL addresses the problem as a relatively static entity with the function to catalyse the project work and set boundary conditions and requirements of the solution, whereas in PBL, the problem is dynamic, changing and used in the project work as an active processual and facilitating tool. For instance, in an SBL context students might be confronted with a fixed and well defined task such as developing a design for a public square that comply with certain needs and specifications. Here the problem *is* how to solve that particular, and no other, task and therefore it can be reduced to merely a starting point for the project that clearly defines the end goal and objective. Contrary, in a PBL context, the students can still be confronted with a fixed and well defined task such as developing a design for a public square, but this is only to be a starting point for their process in which they are themselves responsible for scoping and focusing their project. Thus, the problem in this context becomes a function of the students’ accumulated work and a representation of the project’s current and future orientation. When combining teaching and tuition didactics from these two different approaches, as at A&UD, we cannot avoid some level of friction that needs to be dealt with by teachers in both planning the project module as well as in their handling of project tuition which we will touch upon in the next section.

Furthermore, we might also observe that in the AAU PBL description of the problem it is stated that in addition to being ‘authentic’, the problem must also be ‘scientifically based’ (Askehave et al., 2015). This characteristic possibly further widens the gap between the understanding and function of the problem in the PBL and SBL approaches. In SBL the catalysing problem will often take shape as a ‘practical’ problem that does not necessarily accommodate the inherent scientific scope and obligation of the learning process in the AAU PBL environment. At AAU the problem resembles more the ‘research question’ from the traditional university learning environment. Ideally, the problem, or the research question, is the compass that guides and sets the trajectory of the scientific work and inquiry. It points to and guides the students’ choices of methods, theories, analytical approaches to understanding the problem and ultimately the solutions they end up finding and/or developing. Consequently, although SBL is not directly incompatible with the ‘scientific’ scope of the AAU learning model, being scientific is not an

inherent element either, and therefore it has to be explicitly accommodated in an integration of the two approaches in the individual teaching practice to comply with AAU PBL expectations. Without going into a discussion of whether the operationalisation of the ‘problem’ at A&UD actually constitutes a general problem in the student’s project work (that would take empirical material beyond the scope of this discussion paper), we can safely acknowledge that the ‘problem’, being *authentic*, *dynamic* and *scientific*, becomes a point of friction between multiple didactics when having PBL as backbone for student tuition in the A&UD programmes.

Didactic Friction in Project Supervision

In the previous section we illustrated and discussed how the friction of different didactics in tuition practices at the A&UD programme might influence and structure foundational elements in the students’ learning process. In the following, we argue that these possible ramifications of combining didactics (more or less intentionally) and their effects, are not isolated to *the problem*, but saturate other core elements in the teaching practice. To illustrate this, we will now propose and discuss the tuition that groups receive in relation to their project work as yet another arena of possible didactic friction at the A&UD programmes. To unfold this, we will again take point of departure in a narrative, this time illustrating a supervision meeting with a group of students at the A&UD programme:

Halfway through the project period the group presents plans and sections of a dwelling designed for a family of four, and they ask their supervisor to comment on the design proposal. The supervisor looks at the plan and says: "I can see that you have worked with some of the issues we talked about at our last meeting – you have moved the stairs so you now get a better flow and a more rational plan that can be furnished in different ways. However, you have also made a radical change here, moving a room from ground floor to first floor – what qualities does that provide?" "Well, we thought that it would be nice for the family to sleep on the same floor", one student answers. The supervisor continues: "Ok, I can see that might be a quality, but it also gives rise to some other critical questions, for example: what happens to the amount and distribution of daylight in the apartment, when you add the extra room on first floor? And how does it affect the spatial qualities of the apartment and the relation between the two floors?"

Here we see a typical situation of students discussing concrete specifications of a design, in this case a dwelling, in relation to the need of their selected user group. The supervisor asks critical questions on the basis of the presented drawings in order to facilitate reflection on their design choices and process and in this way guide them to realise possible inadequacies and problems themselves instead of explicitly pointing them out. This corresponds to what Dahl (2008) defines as ‘process supervision’. Generally, Dahl distinguishes between two types of supervision supporting problem based project work; one focusing on the *process* and one focusing on the *product*. Table 1 shows an overview of the characteristics of the two supervision

styles. By asking questions and pushing for (collective) reflection on the opportunities and challenges of the tentative design proposal, the supervisor brings into focus the *process* and trains the students' ability to learn how to deal with the challenges they face. Crudely put, we understand *process supervision* as an attempt to support the group members' learning by focusing on the quality of the process of making the product, while *product supervision* attempts to support the group members' learning by focusing on the quality of the product itself.

	Product supervision	Process supervision
Focus	Quality of the product	Learning how to learn
Type of dialogue	Specific (definite) answers	Questions and co-reflections
	The supervisor may point out specific inadequacies	The supervisor may guide the students to realise possible inadequacies
Controlling or supporting	<i>Controls</i> the project work by checking and criticising the students' working papers <i>Supports</i> by formulating problems for the students or give instructions for specific theoretical or methodological approaches	<i>Supports</i> the students' own reflections through dialogue Proposals for specific theoretical or methodological approaches can be process supervision if the aim is to get the students to relate reflectively to them
Assessment focus	- strengths and shortcomings of the project report - what the students have understood	- the students' ability to 'learn how to learn' at the examination - students' ability to respond critically and reflectively to their own work
Level of learning	Single loop learning	Double loop learning

Table 1: Characteristics of "product supervision" and "process supervision", based on Dahl (2008).

These styles of supervision are of course ideal types and seldom occur in their clear form in the actual tuition practice. Importantly, a PBL approach promotes neither of the tuition styles as best practice, but rather see them as 'teaching tools' to be employed in dealing with different

types of tuition situations. It is our experience that supervision at A&UD often draws on both supervision styles. The narrative gives an impression of how the product, the students' design proposal, plays a central role in the tuition. It is both a *product*, which the group members and the supervisor together seek to improve, and it is an expression of the *process*, which the supervisor uses as a medium for supporting discussions and reflections of the process. Finding a suitable balance between *product* and *process supervision* can be quite complex, as it depends on the students' level of understanding and skills, the specific teaching situation and the curriculum learning goals.

Generally speaking, in our experience, students at lower semesters often need another kind of tuition than students at higher semesters, where they should be able to master the fundamental concepts and skills of the discipline and therefore be able to handle higher complexity in their project work as well as be more reflective and conversant on their work process. Although a PBL approach might stress the importance of process awareness and reflective capacity as fundamental building blocks in learning, there is a clear understanding that the effective way to learn any discipline or subject is non-linear and requires the supervisor to be able to prescribe various types of tuition. In illustrating this, Dahl (2008) considers four ideal types of supervision that correspond to different levels in students' qualifications (see Figure 1).

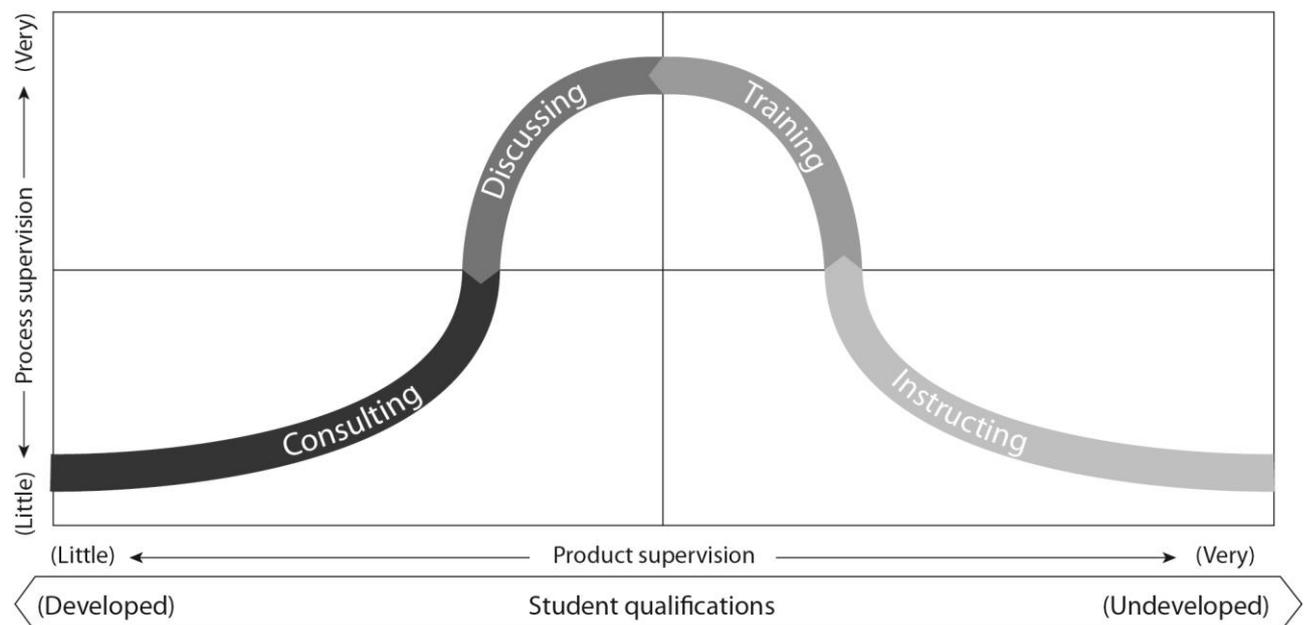


Figure 1: Type of supervision matching student qualifications (from Dahl, 2008, p. 93).

This model illustrates how the product and process focused supervision might be balanced differently. One could expect that this represents a linear progression from 'instructing' and 'training' at undergraduate level, to 'discussing' or 'consulting' at postgraduate level. However, in practice this is more complex as the qualifications of the students might vary widely across semesters and across students in the same group. Furthermore, as the difficulty of taught material and competencies increase each semester, some students might need the 'instructing'

or ‘training’ supervision even at later semesters. If the learning curve across semesters is too steep the consequence might be that the supervisor feels it necessary to take more control and gravitate towards a stronger project focused supervision. Although we should understand these types of supervision as tools, the underlying objective in PBL is to equip the students with strong reflective capacity alongside becoming proficient in the particular discipline. This is sometimes referred to as ‘double loop learning’ (Argyris, 1992), where ‘loop’ metaphorically denotes the students’ proficiency to critically reflect on their own perspective, product and work process. As also shown in Table 1, this level of learning is often supported best through *process supervision* and not through *product supervision* (Dahl, 2008).

Now, if we turn to the architectural teaching tradition that intersects with PBL at the A&UD programme, we find not only a much more insisting focus on the product (Pihl, 2015; Dahl & Kolmos, 2015) but also an underlying understanding of how learning is most effectively achieved. Donald Schön (1983), who has written extensively on learning and teaching in the field of architecture, provides a seminal example where a teacher reviews his student’s initial design at a design studio (traditional in schools of architecture and similar to a SBL setup). As in our narrative, the student in this case presents drawings and describes the problems she is facing. The supervisor places a sheet of tracing paper over her sketches and begins to draw while at the same time describing what he is drawing:

“The kindergarten might go over here . . . then you might carry the gallery level through-and look down into here . . .” (Schön, 1983, p. 80) (....) “The principle is that you work simultaneously from the unit and from the total and then go in cycles . . .” (Schön, 1983, p. 81) (....) “No good, horrible – it just ruins the whole idea – but if you move it over there, it is in a better location and opens up the space” (Schön, 1983, p. 81)

This ‘master-and-apprentice’ approach is epitome in the architectural tradition in teaching as in practice. Here, the teacher or senior architect carefully instructs how to approach the task practically and gives specific proposals as to how a particular design can be changed and developed while at the same time visualising through drawing and words the effects of these architectural gestures. Through this practice the teacher introduces the student to some of the basic elements of the architectural discipline. Drawing on larger experience and knowledge, the supervisor may reject one idea and suggest another while motivating their choice. In many ways this type of tuition shares the characteristics of the *project supervision* proposed by Dahl (2008), cf. Table 1. This approach to teaching that Schön illustrates here does of course leave room for variation and is practiced differently at different schools of architecture, but still this transferring of knowledge and skills through exemplification is thought of as the primary mode of learning. Contrasting this is the PBL approach in which applying and combining these supervision styles according to a given situation is not only an option but a fundamental didactic mode to learning.

Hence, when looking into the particular teaching situation at A&UD we yet again find teaching practices to be far from straight forward but complex, dealing with multiple factors such as student competences and curriculum, but also the friction that naturally occur when combining different didactics of PBL and the architectural teaching tradition. Obviously, as we have explained, applying the type of tuition, as described by Schön, might be well suited in some situations at A&UD. For instance, when dealing with the problem, as reviewed in the prior section, we quickly realise that applying absolute product based supervision regardless of the students' academic level and competencies makes it a challenge, in our perception, to achieve "double loop" learning and critical self-reflection. If we are to follow a PBL approach, providing the students with a problem for them to solve is not desirable, rather the tuition at this point should support the students' internal process of discussion and eventually clarification of their own problem formulation. At times this might be best done by applying *product supervision* pointing towards concrete problems as to exemplify and provide a starting point for the students, whereas at other times it might require process based tuition by asking critical questions to make the students reflect, take ownership and responsibility for the decisions. This leaves a lot of responsibility on the teacher as they must be able to assess the particular learning situation and administer the right type of tuition on-the-fly.

This requires, in our opinion, that we as teachers are constantly aware of what we call didactic friction, and furthermore, critically consider and reflect on when and how PBL and discipline specific didactics are fruitfully applied and/or combined in our teaching practices at A&UD. Contrary to master-and-apprentice learning didactic, PBL is a constructivist understanding of and approach to learning in general (Dahl & Kolmos, 2015). The students 'construct' new knowledge and their own understanding of a given subject by working with it themselves. This cannot be invoked simply by transferring knowledge from the teacher or supervisor to the student through instructions and commands of what to do and not to do even if accompanied by motivations and explanations. Rather, learning is provoked by the student's own reflections upon the problem and situation and experiment with applying the knowledge at hand, and thereby comes to make genuinely own decisions in the design process which again are reflected upon in a looping process (double loop). In short, while Schön's and the architectural tradition's master-and-apprentice learning didactics are based upon *learning by example*, where the student is shown and exposed to expert handling of a problem and then mimics that, we might fundamentally understand PBL differently, as based upon a *learning by practice* philosophy in which the student performs own experiments, makes own choices and draws own conclusions from results.

CONCLUSION

This paper aimed to investigate what has been termed didactic friction when PBL meets discipline specific didactics at A&UD. First, we identified didactic friction as a way of

elucidating the effects that arise when combining different learning didactics. Second, we highlighted two examples of didactic friction, where PBL intersects with the architectural learning tradition at the A&UD programmes. This was done based on two narratives focusing on *the problem* and *project supervision* respectively. The first narrative touched upon the gap between the students and the supervisors' comprehension of the learning process in general and the differences of what role and function *the problem* as a didactic element plays in the learning process. The second narrative touched upon supervision styles, which is approached differently in PBL and in the traditional architectural tradition (SBL). On the basis of these narratives we have illustrated and argued that the project focused 'master-and-apprentice' supervision known from SBL is beneficial when it comes to some discipline specific learning objectives. This, however, should be supplemented with elements from PBL didactics, including process focused supervision if we are to ensure that the *problem* is treated as *authentic, dynamic* and *scientific* and if our *project supervision* is to support and facilitate the students' ability to 'learn how to learn' and respond critically and reflectively to their own work. Through these two examples, we have illustrated that the didactic frictions are not just superficial issues that can easily be clarified, but more deeply rooted consequences of combining didactics from different disciplinary traditions that subscribe to different perspectives on how learning is best achieved, and, therefore, should be considered carefully.

FUTURE PERSPECTIVES

Based on the above discussions about didactic friction, we have identified three focus areas that could aid in turning didactic friction into a strength for our teaching practice:

1. *More discipline specific PBL expertise within teaching staff*

As Savin-Baden (2000) points to, PBL is not a coherent and easy definable method, but exists in many variations. This is also the case in the A&UD programme which represents a cross-disciplinary education environment drawing from both architectural and engineering traditions mixed with PBL. While integration of PBL with various disciplines is possible, this does not necessarily succeed without the teachers' being explicitly aware of this and capable of managing the teaching practices in a reflexive manner. Typically, teachers come with different educational and professional backgrounds, teaching experiences and personal didactic beliefs. On top of this, some teachers teach without having received formal teacher training. Even if all teachers have a general understanding of PBL and are aware of the potential problematic integration with their specific discipline, there is no guarantee that they follow the same form of PBL. Therefore, greater effort and resources need to be put into communicating and training teachers in the specific form of AAU PBL that is pursued at A&UD.

2. *Elucidating and formalising 'teaching culture'*

At the A&UD programme there is no protocol for how teachers should integrate PBL into their teachings. Rather, there is multiple unwritten practices based upon collective tacit knowledge and teaching experience that teachers draw upon in their teaching practices. Teachers with less experience often look to their seniors as role models, and reproduce teaching practices from their own student-teaching experiences. While this teaching culture can be a good environment for transferring best practice, there is also the risk of the opposite, where teaching practices coagulate or is mindlessly reproduced. Therefore, to develop successful teaching practices and promote existing exemplary teaching practices that explicitly recognise and deal with didactic frictions, teachers need to share teaching experiences and successful teaching methods and bring this into a continuing discussion of *how* we (should) teach within this intersection of engineering, architectural and PBL didactics. For this to happen, developing and organising teaching need to be handled not only individually but also be more administratively and collectively supported, for instance through workshops, seminars and sparring for improving and revising teaching activities.

3. *Equipping students better*

Students are expected to be able to deal with different ways of teaching because supervision styles might differ not only at different times in the learning process, but also as the students meet different teachers. For the competent student that already has reflexive capacity this might not be a problem, but for more insecure and less capable students this might pose a challenge that manifests as frustration. PBL requires the students to dynamically recognise and react to changing supervision styles. On top of this, if the students must also navigate non-articulated shifts between SBL and PBL tuition styles, this may be a cause for further frustrations. This increases 'transactional costs' and potentially puts a strain on supervision resources as teachers have to explicitly ensure that students understand their learning situation and its dynamics. At AAU students get introduced to PBL at their 1st and 2nd semester, where they normally also are assigned an additional PBL and process oriented co-supervisor. However, from 3rd semester and up, they are expected to deal with PBL on their own, only guided by their project supervisor, and depending on the teacher's own background and didactic approach, PBL may be represented in varying extent. In order to secure successful PBL integration in the programme, more support could be provided to students to enhance their understanding and skills of using discipline specific PBL beyond their first year of studies.

We have pointed to earlier that much responsibility lies upon the teachers who are at the forefront of organising and conducting teaching. However, it is our belief that teachers in general attempt to develop the best possible teaching within the given circumstances, and any change is therefore not only rooted within the individual teachers and their teaching practices,

but also the institutions and administration that sets the conditions that frame teaching. To us it seems clear that dealing with didactic frictions, which seems to be inherent properties of PBL and cross-disciplinary educations, is a joint effort. Indeed, we need teachers on an individual basis to see and recognise these potential troublesome issues in their teaching, but more importantly, we need the university and study administration to equally recognise this and improve the conditions that empower and support teachers in coping with didactic friction.

With a point of departure in our own teaching and supervision experiences, we acknowledge the complexities, non-linearities, and consequences of integrating PBL with other teaching traditions and learning approaches in tuition practices. Being a common and nearly unavoidable issue in cross-disciplinary teaching practices, we find it problematic if didactic friction is either overlooked or disregarded. With this paper we hope to create awareness of the importance of consciously handling didactic friction in discipline specific PBL tuition.

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