GI_Forum 2022, Issue 1
Page: 107 - 119
Full Paper
Corresponding Author:
muschaweck@geo.uni-frankfurt.de
DOI: 10.1553/giscience2022_01_s107

Constructions of Space and Social Networks – First Insights into a TPACK Survey for Geography Teachers

Isabelle Muschaweck[1] and Detlef Kanwischer[1]
[1]Goethe Universität Frankfurt, Germany

Abstract

In the digital condition, social networks are part of the everyday practices that produce constructions of space. To include this phenomenon in the Geography classroom, the corresponding knowledge that teachers require and how to measure it need to be determined. For this purpose, a specific instrument is necessary. We analyse constructions of space as a teacher knowledge domain through the lens of the TPACK model and deduce pedagogical and technological knowledge. We then combine these results with available TPACK survey instruments. The product is a self-assessment survey for Geography teachers on constructions of space and social networks. Scale consistency measures and item discrimination yielded good results. Initial results indicate technological and pedagogical knowledge to be greater than content knowledge. The instrument we present is valid for determining future Geography teachers' TPACK more broadly, and can reveal implications for interventions in Geography teacher education.

Keywords:

TPACK, digital Media, geography, constructions of space, teacher education

1 Introduction

In today's society, the digital is part of everyday life, interwoven into everyday practices. Interpreting 'real-life' encounters, forming an opinion or communicating with friends are all embedded in a base of digital information. Consequently, it has become increasingly difficult to differentiate between 'the digital' and the 'non-digital'. Stalder (2018) labels this 'the digital condition': a societal state defined by *referentiality*, *communality* and *algorithmicity*. We will illustrate these terms in the context of social networks, as these are environments of everyday practices in the digital condition. Say, for example, you take a photo of your city (e.g. Frankfurt) and add #Frankfurt to the photo's description when posting it on Instagram. This simple act of ascribing a location through a hashtag links this picture to a number of other photos under the same hashtag (*referentiality*). To add a little perspective: searching #Frankfurt on Instagram produces 12.1 million results (as of 11 January 2021). What is already implied here is that your post is 'quoting' other posts in the choice of photo location, camera angle and curation (i.e. through filters). This iterative and constant production of content and thereby meaning in turn

produces a community in which this meaning is preserved (*communality*). *Algorithmicity* is present in all the actions described above, as algorithmic decisions bundle the content made available to us and therefore co-produce social networks.

The phenomenon illustrated in the example can be referred to as an instance of constructions of space, because the images and posts are highly charged with contextual meaning. On social networks, constructions of space become accessible through analysing everyday (communicative) practices that are performed against the backdrop of a digitally augmented world (see Reithmeier, Kanwischer & Schulze, 2019). As a phenomenon of the digital condition, constructions of space are ingrained in students' and teachers' everyday practices, and are constantly available through extensive social network and mobile devise usage. As such, they can become fruitful instances of reflexive learning *through* the digital in the Geography classroom.

However, for Geography teachers to be able to implement constructions of space, there are a number of prerequisites. Therefore, our superordinate research question reads:

1. What knowledge do Geography teachers need if they are going to include constructions of space in the classroom?

This requisite knowledge, then, needs to be fostered in Geography teacher education. However, this prompts the following question: what knowledge do Geography teachers already possess in the field of constructions of space and social networks? Before this question can be answered, we need to have some way of measuring teachers' knowledge and abilities. Therefore, we pose the following question:

2. How can this knowledge and these abilities be measured?

We propose to approach these questions by analysing the literature on constructions of space, and corresponding media education approaches, through the lens of the Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler, 2006). Building on this, we will examine available instruments for measuring teacher knowledge in the area of the digital. Finally, we will present our own survey for measuring Geography teachers' technological-pedagogical-content knowledge of constructions of space and social networks.

2 The TPACK model of teacher knowledge

We selected the internationally recognized TPACK model for teacher knowledge as a frame of reference (Mishra & Koehler, 2006). Building on Shulman's (1986) knowledge domains of Pedagogical and Content knowledge, as well as their intersection (Pedagogical Content Knowledge), the TPACK model introduces Technology as a third independent knowledge domain. At the same time, it presents the intersections of these domains as specific knowledge spheres themselves (Fig. 1).

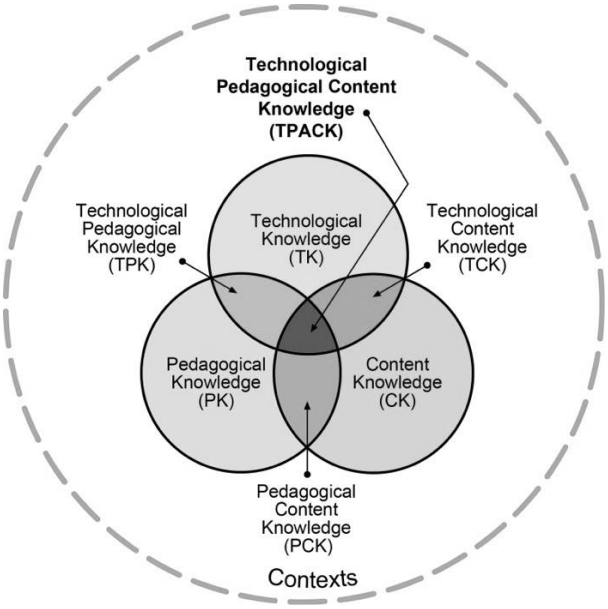

Figure 1: TPACK model (Mishra & Koehler, 2006); Reproduced by permission of the publisher, © 2012 by tpack.org

Following Mishra and Koehler (2006), technological pedagogical content knowledge is applied in practical teaching in the classroom. Here, for successful teaching, the various knowledge spheres of the model need to be blended together by the individual teacher in compiling tasks, giving instructions, etc.

In the context of the digital, the TPACK model has been criticised for narrowing down the areas of knowledge required by teachers (e.g. Schiefner-Rohs & Hofhues, 2018). At the same time, it has been criticised for its broadness, which could hinder its effective application (e.g. Brantley-Dias & Ertmer, 2013).

We take these criticisms seriously and consider them in our adaptation of TPACK; we add knowledge of social networks and more general knowledge about digital media to the technological sphere. Through this, we strive to move beyond a view of digital media as instruments towards a view of the digital and media as everyday practices.

3 Knowledge domains

Building on the areas of teacher knowledge identified by Mishra and Koehler (2006), we systematically analysed the literature on the knowledge that teachers need in order for them to be able to include constructions of space in the classroom. In what follows, we will briefly present the results for each knowledge realm. As constructions of space as a topic within Geography education are the starting point of our considerations, we will present the content-knowledge domain first. Subsequently, we will deduce related pedagogical and technological knowledge.

3.1 Content Knowledge (CK)

Constructions of space are embedded in our digital society, in which space is produced through actions and communication (Werlen, 1997) in the context of everyday spatial big data (Leszczynski & Crampton, 2016). On a broader level, constructions of space are a topic of digital Geographies that illustrates a restructuring of everyday societal and individual relations to space, as summarized by Felgenhauer and Gäbler (2019). Constructions of space are thus representative of a *social* construction of space as discussed pre-digitalization (see e.g. Werlen, 1997). Simultaneously, in the context of the digital age, constructions of space are examples of the restructuring of medial representations and (re-)emerging power structures (Felgenhauer & Gäbler, 2019). Concretely, constructions of space are defined by the co-creation of content by individuals, society and assemblages of algorithms on social networks. The resulting phenomena (i.e. examples of constructions of space) are at the centre of the realm of content knowledge (CK).

Graham (2017) refers to the intertwining of 'online' and 'offline' spaces as 'augmented geographies', while Leszczynski (2015) positions social networks as part of everyday practices infused with digital geomedia information. This results in "a digital 'mediation' of everyday life by spatial information (Leszczynski, 2015). Such integrative approaches to space and the digital constitute the background knowledge within CK.

In everyday life, constructions of space are (re-)made in practice, including the reproduction of spatial and social inequalities. Butler, Schafran and Carpenter (2018), for example, illustrate this in their investigation of defamatory meaning ascribed to specific places (in posts on social networks) and how this results in the increased marginalization of these places. A similar conclusion is drawn by Boy and Uitermark (2017), who contrast the exclusive image constructed of a place online with the resulting social exclusion of individuals who are unable to participate. These characteristics of constructions of space constitute the specific CK needed.

3.2 Pedagogical Knowledge (PK)

To meet the pedagogical requirements posed by an integrative view of the digital and society, we select integrative approaches in media education. Such approaches also start from the individual's involvement with media (i.e. the digital), and thus allow for a smooth application of CK through pedagogical knowledge (PK). Concretely, this means learning reflexively through creative practices.

Following Allert, Richter and Albrecht (2018), creative practices are the ways of acting and making sense of the world that are shared collectively. They are applied in 'uncertain, ambivalent or unsecure [situations] and hence are open to multiple forms of interpretation and interaction' (Allert, Richter & Albrecht, 2018, 13). In the context of social networks, such situations are the norm and gain relevance in relation to interactions with others, as communication – and thus creativity – is called for (Richter & Allert, 2015). Furthermore, reflecting on one's own practices in the context of the self and social networks is vital. Only then can possibilities for action be explored and applied productively in autonomous action (Jörissen, 2016).

Reflexive learning through creative practice thus needs to be the focus of PK when dealing with the subject of constructions of space in the classroom. On a subordinate scale, teachers need to be able to construct learning environments in which reflexive learning through creative practices can take place. These environments need to be broad enough to allow room for individuality; they must also foster exchange with others in order for teachers (and their students) to experience the embeddedness of their own practices.

3.3 Technological Knowledge (TK)

As constructions of space are enabled through social networks, knowledge of the technological aspects of social networks is a primary necessity in the realm of technological knowledge (TK). Here, we define social networks in a broad sense, as the platforms that enable users to communicate information and interact with others (Burgess, Marwick & Poell, 2018). Examples include Instagram or Twitter, as well as messenger services such as WhatsApp. The integrative view of the digital and society again comes into play here, as the focus is on the everyday use of social networks in social practice. This is in contrast to the *functional* use of social networks, for example being able to 'log into an account' or 'push the "like" button'. The technological knowledge required for constructions of space consists of an everyday immersion in social networks and it can only be acquired through this immersive engagement.

Due to the integration of social networks with digital media content (such as newspaper articles to which there are links from social media, or digital photo albums presented on social networks), knowledge about digital media is also important for constructions of space. As social networks themselves are embedded in the digital society, they are intertwined with (visual, audio-visual or textual) information that is provided digitally. Consequently, knowledge about digital media is the second constituent of the technological knowledge realm.

3.4 Pedagogical-Content Knowledge (PCK)

Following Mishra and Koehler (2006), teachers blend CK with PK to establish teaching routines in pedagogical-content knowledge (PCK). For our content focus on constructions of space, this necessitates a combination of constructions of space and reflexive learning through creative practices in devising learning environments. Such environments require the development of tasks for students in the classroom, and the exercising of one's role as learning facilitator and advisor. Consequently, the facilitation of these learning environments forms the core of PCK for constructions of space.

Regarding the learning environments, we suggest that they focus on students' reflection on their own creative practices on social networks, the creation of their own content, as well as exchanges with other learners. These exchanges serve to foster a critical appreciation of one's own practices as embedded in communal practices (Richter & Allert, 2017).

3.5 Technological-Content Knowledge (TCK)

The representation of content through technological means constitutes teachers' technological-content knowledge (TCK) (Mishra & Koehler, 2006). For constructions of space, this underlines the importance of teachers' ability to select exemplary content on social networks for use in the classroom. In TPACK, these examples become interconnected with PCK in that they serve in the design and elaboration of the learning environments created through PCK.

3.6 Technological-Pedagogical Knowledge (TPK)

Integrating PK with technologies results in technological-pedagogical knowledge (TPK). In line with the knowledge domains already presented, this calls for a connection to be made between social networks and reflexive creative practices.

Teachers' TPK thus surfaces in learning environments that include social networks as opportunities for learning. Concretely, this refers to the creation of content on social networks by the students themselves, reflection on the related social network practices, and on the shared nature of their own experience and practice. As a supplement to PCK, in TPK a greater focus is placed on the technological aspect of social networks and their integration into everyday practices.

3.7 Technological-Pedagogical-Content Knowledge (TPCK)

The combination of all areas of knowledge with each other is referred to as teachers' technological-pedagogical-content knowledge – the core of TPACK. Following Mishra and Koehler (2006), this knowledge for us implies the appropriate combination of constructions of space, social networks and reflexive learning through creative practices in the Geography classroom. This area of knowledge is the most complex, as it necessitates knowledge of all domains previously described. It is applied by teachers in the action of teaching, which itself is a constant solving of unstructured problems (Mishra & Koehler, 2006).

4 Operationalization of the knowledge domains

The domains of knowledge outlined above provide the theoretical backdrop for the following review of existing TPACK instruments and the item selection process. Here, we adopted existing items to allow for the comparability of our results. Additionally, we remodelled existing items based on our theoretical background and developed new ones where necessary. Through this, the knowledge domains were operationalized and led to the final *TPACK Survey on Constructions of Space and Social Networks*.

4.1 Analysis of available TPACK surveys

Since the introduction of the TPACK model, qualitative and quantitative approaches for measuring teachers' TPACK have been developed. In qualitative research, these include posing complex tasks, such as the development of lesson plans, that require the application of TPACK. In order subsequently to analyse the levels of teachers' TPACK, assessment rubrics were developed or interviews conducted (for a summary, see Archambault, 2016). In quantitative research, self-evaluation instruments dominate the methods of data collection (see the meta-study by Wang, Schmidt-Crawford & Jin, 2018). Such instruments ask participants to assess their own knowledge in the knowledge domains of the TPACK model, on a Likert-type scale. The resulting data thus provide insights into teachers' skills and abilities while also assessing their more general confidence in these skills. In the context of TPACK, self-evaluation has been criticised as being dependent on the teachers' academic self-concept (Mouza, Karchmer-Klein, Nandakumar, Yilmaz Ozden & Hu, 2016; Drummond & Sweeney, 2017). We view this criticism as well founded. Nevertheless, we follow in the footsteps of existing self-evaluation instruments. This is due to the novelty of our topic, which is still being discussed and is continuously expanding in the field of Human Geography (see e.g. Ash, Kitchin & Leszczynski, 2018 on the digital turn in Geography). We also wished to gain insights into teachers' current knowledge regarding constructions of space and social networks, in order to apply the results in planning follow-up interventions. Furthermore, well-established self-evaluation instruments for TPACK are available and thus provided guidance for developing our own survey instrument. Based on criteria of test validity and thematic relevance, we systematically reviewed available TPACK instruments and identified four that were suitable for our goal.

Among TPACK self-evaluation instruments, the 'Survey of Preservice Teachers' Knowledge of Teaching and Technology' by Schmidt et al. (2009) has received the widest acknowledgment. Over the last ten years, this instrument has been successfully revised and adapted multiple times – for example by Doering, Koseoglu, Scharber, Henrickson and Lanegran (2014) in the context of Geography education. This adaptability and the numerous successful empirical applications make Schmidt et al.'s survey the starting point for our consideration. Additionally, we selected surveys that emphasize the increasingly digital nature of society and/or the correspondingly changed pedagogical demands on teachers. While Chai, Ling Koh, Tsai and Lee Wee Tan (2011) still focus on technological knowledge, they demonstrate a shift from general technology to information and communication technology (ICT). As social networks in a broader sense are part of ICT, we considered Chai et al.'s survey in the development of our own. Valtonen et al. (2017) also approach ICT, but shift the focus on to the corresponding pedagogical knowledge. They contextualize this in the realm of twenty-first-century skills. This provides us with additional insight into how to align technological content with pedagogy in our survey. Finally, we included the survey by Schmid, Brianza and Petko (2020), who aim for a condensed version of previous surveys. This particular survey helped guide our selection of items in light of their relevance for scale validity.

4.2 Adaption for Constructions of Space

None of the surveys we adapted addresses one subject in detail. Rather, they all remain vague regarding the realm of content knowledge. A content knowledge item by Schmidt et al. (2009, 146) illustrates this: 'I have sufficient knowledge about social studies.' Here the knowledge required remains undefined. This is where our instrument differs notably from available instruments. Instead of addressing (perhaps insufficiently) the entire breadth of one school subject, we zoom in on one topic within the subject: constructions of space. This choice is justified by the novelty of the topic. We cannot expect participants to be familiar with its various aspects and particularities. This approach also enables us to confront participants with important constituents of the topic, including the underlying reliance on space as a social construct, which is itself the frame for constructions of space.

In contrast to the realm of content knowledge, the other knowledge spheres are more nuanced in the instruments that were already available. This is why we did not develop completely new items for these spheres, but used existing instruments as starting points. More concretely, this means that we inserted 'social networks' into the area of TK. As a result, the areas intersecting with TK (and CK) contain items on both social networks and constructions of space. We also adjusted the PK items to reflect our media education approach better. To ensure that participants understood the items accurately, we provided definitions of the central concepts of constructions of space and social networks.

Lastly, we would like to point out that all the TPACK instruments we adapted were originally in English. As our study targeted German teachers, we translated the items into German and revised them as appropriate. For the purpose of this publication, we have retranslated them into English.

5 Methodology and first results

Based on discussions with experts in the field of educational research as well as a pre-test (n=25) and a group discussion (n= 5) with students, we revised our instrument. The result is the *TPACK Survey on Constructions of Space and Social Networks*. This self-report survey serves to measure trainee Geography teachers' and in-service Geography teachers' knowledge in all areas of TPACK in the field of constructions of space and social networks.

To test the validity of our survey, we devised a corresponding online questionnaire, which was distributed through mailing lists to thirteen universities and two professional bodies for Geography teachers. In total, 364 people participated in the survey. The majority of participants (n= 347) were university students training to become Geography teachers, or primary school teachers studying Geography as part of their training to become general studies teachers. The remaining participants were in-service teachers (n=17). The profiles of our participants therefore suggests that our instrument is valid for measuring student teachers' TPACK. Further investigations would need to be made to determine its validity for in-service teachers. Of the university students, 43% (n= 118) worked in schools, for example as replacement teachers. Participants' mean year of birth was 1996 (SD= 5.85). Consequently, participants were predominantly in their mid-20s, which should be kept in mind when

interpreting the results. 24.5% reported their gender as male (n= 89), 72% as female (n= 264). This gender imbalance is striking but reflects the general gender imbalance among German teachers. As determined by the OECD (2021, 404), around 60% of teachers in secondary schools are female; in primary schools, the figure reaches 87%. As a significant number of our participants are future primary school teachers (n= 105), we consider the gender imbalance in our study to be a reasonable reflection of the general situation.

As a measure of reliability, we calculated Cronbach's Alpha, which yielded excellent results for all scales. With the exception of TK1, the corrected item discrimination of all items was also satisfactory. This indicates that the survey allows for predictions regarding answers of lower- and higher-scoring participants. Regarding TK1, it remains to be decided whether to exclude this item from future analyses altogether.

Table 1 displays the *TPACK Survey on Constructions of Space and Social Networks*. Here, participants assessed their knowledge on a four-point Likert-type scale (disagree – disagree to some extent – agree to some extent – agree). Descriptive statistics and corrected item discrimination are provided for each item, while scale statistics follow the items for each scale (in bold).

Bearing the limiting non-random sample and participants' relatively young ages in mind, we will highlight with a degree of caution the first insights gained from our survey. Concerning the independent knowledge domains (TK, PK & CK), CK (M= 2.94) scores less than TK (M= 3.19) and PK (M= 3.15). We interpret this as confirming our assumption that teachers are less familiar with constructions of space due to the novelty of the topic. Within the CK scale, the item we rate as the least challenging (CK25) is evaluated the highest by participants. At the same time, knowledge on the 'interweaving of space and social networks' (CK21) is evaluated the lowest. This item is more complex and refers to the theoretical background of constructions of space. We interpret this knowledge gap as alluding to a possible lack of theoretical knowledge about constructions of space, albeit more familiarity with their everyday manifestations.

In general, our participants appear to be apt users of social networks and digital media in their personal lives (e.g. TK3, TK4, TK11). However, it is notable that in the professional context, digital media usage (TK4= 3.10) is far greater than social network usage (TK10= 2.60). This difference implies less experience in integrating social networks in the classroom and thus fewer opportunities for developing related TPACK. This fits with the results of the integrative knowledge domains (TPK, TCK, PCK and TPCK). None of these achieve a mean above 2.92 (=TCK). This allows the tentative conclusion that the *conjunction* of the independent knowledge domains with each other in TPK, TCK, PCK and TPCK (which is necessary to solve practical teaching tasks) is the greater challenge, as knowledge in these composite domains is below teachers' knowledge in the independent knowledge domains of TK, PK and CK.

Participants evaluated their knowledge the lowest in the didactics of Geography (i.e. PCK= 2.59). This is surprising, as theoretically TPCK is the most complex and thus we would expect TPCK to be rated the lowest. We would like to draw special attention to this, as it illustrates the need for Geography teacher educators to create learning situations that foster the application of constructions of space and media education through 'real teaching tasks'.

Table 1: Descriptive statistics (M, SD), corrected item discrimination (r) and reliability (α) of the scales and items of the TPACK survey on Constructions of Space and Social Networks

	Item	M	SD	r	α
TK1	Social networks should be used in the context of education.	2.97	0.87	.29	
TK2	I keep up with important new digital media through information sources such as newspaper/journal articles or content on social networks.	3.14	0.83	.53	
TK3	I try out new digital media.	3.04	0.78	.52	
TK4	I use digital media multiple times a day in a work-related context.	3.10	0.94	.38	
TK5	I use digital media multiple times a day in my private life or for entertainment.	3.73	0.55	.55	
TK6	I know many different digital media.	3.57	0.62	.54	
TK7	I have the necessary abilities to use digital media.	3.50	0.63	.47	
TK8	I keep up with important new social networks through information sources such as newspaper/journal articles or content on social networks.	3.03	0.85	.61	
TK9	I try out new social networks.	2.81	0.85	.59	
TK10	I use social networks multiple times a day in a work-related context.	2.60	0.99	.43	
TK11	I use social networks multiple times a day in my private life or for entertainment.	3.55	0.74	.55	
TK		**3.19**	**0.49**		**.82**
PK12	I can guide students' discussions during group work (2-5 students).	3.32	0.58	.64	
PK13	I can support students' critical thinking.	3.17	0.63	.60	
PK14	I can guide students in planning their own learning.	3.16	0.67	.59	
PK15	I can support students' reflective thinking.	3.16	0.62	.65	
PK16	I can guide students to make use of each other's thoughts and ideas during group work (2-5 students).	3.25	0.61	.64	
PK17	I can support students' problem-based learning.	3.11	0.66	.61	
PK18	I can support students' creative thinking.	3.08	0.70	.51	
PK19	I can explore students' spatial socialization with them.	2.92	0.69	.54	
PK20	I can relate my own attitudes towards social networks reflexively to teaching.	3.13	0.68	.40	
PK		**3.15**	**0.45**		**.85**
CK21	I have sufficient knowledge on the interweaving of space and social networks.	2.84	0.72	.59	
CK22	I know different characteristics of constructions of space.	2.96	0.75	.41	
CK23	I can spot relevant underlying phenomena (e.g. dominant discourses, reproduced social inequality, alternative representations) in specific posts on social networks.	2.99	0.76	.63	
CK24	I can identify the spatio-temporal context of specific posts on social networks.	2.88	0.69	.63	
CK25	I can relate posts on social networks on one topic to corresponding "real-life" phenomena.	3.08	0.73	.54	
CK26	I have sufficient knowledge on the potential for participation in social networks.	2.86	0.79	.55	
CK		**2.94**	**0.53**		**.8**
TPK27	I know how to use social networks in teaching as a basis for students' reflective thinking.	2.62	0.81	.69	
TPK28	I know how to use social networks in teaching as a basis for students to construct individual learning paths.	2.49	0.78	.71	
TPK29	I know how to use social networks in teaching as a basis for individual students' problem-based learning.	2.49	0.78	.78	
TPK30	I know how to use social networks in teaching as a basis for students' creative thinking.	2.68	0.83	.68	
TPK31	I know how to use social networks in teaching as a basis for students' problem-based learning in groups (2-5 students).	2.58	0.79	.74	
TPK32	I know how to use social networks in teaching as a basis for students' critical thinking.	2.81	0.80	.67	
TPK33	I know how to use social networks in teaching as a basis for exploring students' spatial socialization with them.	2.65	0.83	.66	
TPK		**2.62**	**0.64**		**.9**
PCK34	I know how to select effective teaching approaches that support students' thinking and learning in constructions of space.	2.64	0.77	.65	
PCK35	I know how to select content on social networks that fosters students' complex thinking in constructions of space.	2.50	0.79	.59	
PCK36	I know how to design tasks that foster students' reflective thinking in constructions of space.	2.54	0.79	.74	
PCK37	I know how to design tasks that foster students' creative thinking in constructions of space.	2.57	0.79	.71	
PCK38	I know how to design tasks that foster students' critical thinking in constructions of space.	2.66	0.78	.79	
PCK39	I know how to design problem-based learning tasks for constructions of space.	2.62	0.78	.72	
PCK		**2.59**	**0.63**		**.89**
TCK40	I have the technological skills to select social media posts representative of constructions of space.	3.07	0.80	.67	
TCK41	I know how to identify new constructions of space appearing on social media.	2.85	0.82	.77	
TCK42	I am familiar with social media that facilitate constructions of space.	2.87	0.86	.73	
TCK43	I know how social networks and their users change the spaces that they co-produce.	2.85	0.87	.70	
TCK		**2.92**	**0.71**		**.87**
TPCK44	I can use strategies that combine constructions of space, social networks and teaching approaches.	2.37	0.81	.69	
TPCK45	I can select constructions of space that combine familiar learning content and new digital applications.	2.64	0.80	.72	
TPCK46	I can select digital media that expand what I teach, how I teach and what students learn, by providing additional levels of comprehension and content.	3.00	0.78	.56	
TPCK47	I can teach lessons that appropriately combine constructions of space, social networks and teaching approaches.	2.50	0.83	.70	
TPCK		**2.63**	**0.69**		**.84**

Items adapted/ revised based on Schmidt et al. (2009), Chai et al. (2011), Valtonen et al. (2017), Schmid et al. (2020); CK items developed by the authors

6 Prospects

We began this article by asking what knowledge teachers need in the area of constructions of space and how to measure it. In the course of our argumentation, we introduced the *TPACK Survey on Constructions of Space and Social Networks* as one possibility. Having developed a valid instrument, we now need to address a follow-up question, to target the current state of Geography teachers' TPACK. While we have provided a glimpse into the situation, further analyses of the interconnectedness of the knowledge domains and of the validity of the TPACK construct for our content focus are necessary.

In a future step, the results of the analysis could serve as a basis for seminars or further education measures. The results from the survey could help to inform decisions on the design of interventions (seminars etc.) and content. For example, the choice of content could be modified based on the knowledge that student teachers of Geography already possess. In the course of all these analyses, it must be kept in mind that our data were obtained by means of self-evaluation and therefore provide but a first insight into a complex topic. Actual knowledge tests could be administered in the future to supplement the self-evaluation data.

Finally, it should be noted that the TPACK model is but one way of determining teachers' knowledge of constructions of space, and the model has its own limitations. Due to its roots in an instrumental view of technology usage, the model is not perfectly suited for representing an integrative view of space and the digital, as knowledge of social networks is separate, being situated in the technological knowledge sphere. This is a weak point in our study. Nevertheless, the definitions of knowledge domains and their combinations facilitate addressing the subject-specific contribution of Geography education to developing digital knowledge by use of the example of constructions of space. The reconfiguration of existing content and the development of new content that come into play here align with demands for the reframing of subject-specific education in light of the digital (see e.g. Gesellschaft für Fachdidaktik [German Association for Subject Didactics], 2018). In this sense, the TPACK model is one possible means for formulating reflexive and critical knowledge in a broad subject area or in specific sub-topics of that area. In this, the approach can be linked to a 'digital personal education' as described by the Gesellschaft für Fachdidaktik (2018, 3), because through it contributions can be made to the broader goals of digital literacy and digital sovereignty, which are of pivotal importance for learners in the digital world.

Acknowledgements

The project that is the basis of this article is part of the 'Qualitätsoffensive Lehrerbildung', a joint initiative of the Federal Government and the Länder, which aims to improve the quality of teacher training. The programme is funded by the Federal Ministry of Education and Research under FKZ 01JA2025. The authors are responsible for the content of this publication.

References

Allert, H., Richter, C. & Albrecht, J. (2018). Seeding and Cultivating Creative Practices in Teams. *Creative Academic Magazine, 9*(B), 12-14. http://www.creativeacademic.uk

Archambault, L. (2016). Exploring the Use of Qualitative Methods to Examine TPACK. In Herring, M.C, Koehler, M.J. & Mishra, P. (Eds.), *Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators* (pp. 65-86). Routledge.

Ash, J., Kitchin, R. & Leszczynski, A. (2018). Digital turn, digital geographies? *Progress in Human Geography, 42*(1), 1-19. https://doi.org/10.1177/0309132516664800

Boy, J.D. & J. Uitermark (2017). Reassembling the city through Instagram. *Transactions of the Institute of British Geographers, 42*(4), 612-624. https://doi.org/10.1111/tran.12185

Brantley-Dias, L. & Ertmer, P.A. (2013). Goldilocks and TPACK. Is the Construct 'just right?'. *Journal of Research on Technology in Education, 46*(2), 103-128. https://doi.org/10.1080/15391523.2013.10782615

Burgess, J., Marwick, A. & Poell, T. (2018). Editors' Introduction. In Burgess, J., Marwick, A. & Poell, T. (Eds.), *The SAGE Handbook of Social Media* (pp. 1-10). SAGE Publications Ltd, https://dx.doi.org/10.4135/9781473984066.n1

Butler, A., Schafran, A. & Carpenter, G. (2018). What does it mean when people call a place a shithole? Understanding a discourse of denigration in the United Kingdom and the Republic of Ireland. *Transactions of the Institute of British Geographers, 43*(3), 496-510. https://doi.org/10.1111/tran.12247

Chai, C. S., Ling Koh, J. H., Tsai, C.-C. & Lee Wee Tan, L. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education, 57*(1), 1184–1193. https://doi.org/10.1016/j.compedu.2011.01.007

Doering, A., Koseoglu, S., Scharber, C., Henrickson, J. & Lanegran, D. (2014). Technology Integration in K–12 Geography Education Using TPACK as a Conceptual Model. *Journal of Geography, 113*(6), 223-237. https://doi.org/10.1080/00221341.2014.896393

Drummond, A. & Sweeney, T. (2017). Can an objective measure of technological pedagogical content knowledge (TPACK) supplement existing TPACK measures? *British Journal of Educational* Technology, 48(4), 928–939. https://doi.org/10.1111/bjet.12473

Felgenhauer, T. & Gäbler, K. (2019). Geographien digitaler Alltagskultur. Überlegungen zur Digitalisierung in Schule und Unterricht. *GW-Unterricht, 1*, 5-20. https://doi.org/10.1553/gw-unterricht154s5

Gesellschaft für Fachdidaktik [Association for Subject Didactics] (2018). *Fachliche Bildung in der digitalen Welt. Positionspapier der Gesellschaft für Fachdidaktik (GFD)*. Accessed through: https://www.fachdidaktik.org/veroeffentlichungen/positionspapiere-der-gfd/

Graham, M. (2017). Digitally Augmented Geographies. In Kitchin, R., Lauriault, T. P. & Wilson, M.W. (Eds.), *Understanding Spatial Media* (pp. 44-55). Sage.

Jörissen, B. (2016). ‹Digitale Bildung› und die Genealogie digitaler Kultur: historiographische Skizze. *MedienPädagogik, 25*, 26-40. https://doi.org/10.21240/mpaed/25/2016.10.26.X

Leszczynski, A. (2015). Spatial media/tion. *Progress in Human Geography, 39* (6), 729-751. https://doi.org/10.1177/0309132514558443

Leszczynski, A. & Crampton, J. (2016). Introduction: Spatial Big Data and everyday life. *Big Data & Society, 3*(2), 1-6. https://doi.org/10.1177/2053951716661366

Mishra, P. & Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record, 108*(6), 1017-1054.

Mouza, C., Karchmer-Klein, R., Nandakumar, R., Yilmaz Ozden, S. & Hu, L. (2014). Investigating the impact of an integrated approach to the development of preservice teachers' technological

pedagogical content knowledge (TPACK). *Computers & Education, 71*, 206–221. https://doi.org/10.1016/j.compedu.2013.09.020

OECD (2021). *Education at a glance 2021. OECD indicators*. OECD Publishing. https://doi.org/10.1787/b35a14e5-en

Reithmeier, C., Kanwischer, D. & Schulze, U. (2019). ViRaBi: Virale Raumkonstruktionen in kulturellen Bildungsprozessen. Theoretische Ansätze und empirische Zugänge**.** In Jörissen, B., Kröner, S. & Unterberg, L. (Eds.). *Forschung zur Digitalisierung in der Kulturellen Bildung* (pp. 201-213). Kopaed.

Richter, C. & Allert, H. (2015). A practice-oriented perspective on collaborative creative design. *International Journal of Design Creativity and Innovation, 3-4*, 1-11. http://dx.doi.org/10.1080/21650349.2015.1069763

Richter, C. & Allert, H. (2017). Design as critical engagement in and for education. *EDeR - Educational Design Research, 1*(1), 1-20. https://doi.org/10.15460/eder.1.1.1023

Schiefner-Rohs, M. & Hofhues, S. (2018). Zurück in die Zukunft. Anforderungen an Medienbildung in der Aus- und Weiterbildung von Lehrpersonen am Beispiel eines Praxis- und Entwicklungsprojekts. *MedienPädagogik 31*, 58-77. https://doi.org/10.21240/mpaed/31/2018.03.28.X

Schmid, M., Brianza, E., & Petko, D. (2020). Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK.xs) and comparing the factor structure of an integrative and a transformative model. *Computers & Education, 157*, 103967. https://doi.org/10.1016/j.compedu.2020.103967

Schmidt, D.A., Baran, E., Thompson, A.D., Mishra, P., Koehler, M.J. & Shin, T.S. (2009). Technological Pedagogical Content Knowledge (TPACK): The development and Validation of an Assessment Instrument for Preservice Teachers. *Journal of Research on Technology in Education, 42*(2), 123-149.

Shulman, L.S. (1986). Those Who Understand: Knowledge Growth in Teaching. *Educational Researcher, 15*(2), 4-14.

Stalder, F. (2018). *The Digital Condition*. Polity Press.

TPACK.org (2012). The TPACK image [image]. http://tpack.org

Valtonen, T., Sointu, E., Kukkonen, J., Kontkanen, S., Lambert, M. C. & Mäkitalo-Siegl, K. (2017). TPACK updated to measure pre-service teachers' twenty-first century skills. *Australasian Journal of Educational Technology, 33*(3). https://doi.org/10.14742/ajet.3518

Wang, W., Schmidt-Crawford, D., & Jin, Y. (2018). Preservice Teachers' TPACK Development: A Review of Literature. *Journal of Digital Learning in Teacher Education, 34*(4), 234-258 https://doi.org/10.1080/21532974.2018.1498039

Werlen, B. (1997). *Sozialgeographie alltäglicher Regionalisierungen. Bd. 2.: Globalisierung, Region und Regionalisierung*. Steiner.