Novice Primary School Teachers' Conceptions of Internet Structure: A Qualitative Analysis

Anna Drobná[1,2][0000-0003-2714-9529], Anna Yaghobová[1][0000-0002-2102-7515], David Šosvald[1][0009-0005-5848-6028], Daniel Šťastný[3][0009-0006-5085-2975], Marek Urban[4][0000-0003-2772-1388] and Cyril Brom[1][0000-0001-5945-0514]

[1] Faculty of Mathematics and Physics, Charles University, Prague, Czechia
[2] Faculty of Education, Charles University, Prague, Czechia
[3] Faculty of Arts, Charles University, Prague, Czechia
[4] Institute of Psychology, The Czech Academy of Sciences

Abstract. This study investigates primary school teachers' conceptions of internet architecture, a largely underexplored area in early computer science education. We analyzed the conceptions of 59 pre-service and novice in-service primary school teachers from the Czech Republic, who are expected to teach the functioning of the internet in their future practice. Participants drew and described their understanding of internet architecture during semi-structured online interviews. Thematic analysis revealed conceptions similar to the conceptions of children, or ones that could hinder the teachers' later understanding of how the internet functions. These findings contribute to the development of educational materials and the preparation of novice primary school teachers.

Keywords: Computer science, Education, Primary school, Pre-service Teachers, Conceptions.

1 Introduction

Computer science education is being introduced or revised at the primary level in many countries, including the Czech Republic [e.g., 4]. Recent trends emphasize the importance of teaching the underlying principles of internet as early as primary school (ISCED 1). For teachers, this presents a new and challenging topic, highlighting the need for effective preparation and the development of appropriate teaching materials. A crucial first step in this preparation is for instructional designers to understand teachers' conceptions of the subject matter [3].

At the primary school level, understanding the basic principles of internet functionality involves grasping simplified concepts such as data storage on servers, data transmission, and awareness of digital footprints and the decentralized nature of the internet. Teaching these fundamental concepts can significantly enhance primary school students' understanding of internet safety.

Conceptions of the structure of the Internet have been explored, particularly in studies with children [e.g., 2] but have been less extensively examined among teachers. This project aims to investigate the conceptions of novice primary school teachers regarding

the structure and functioning of the internet, with a focus on their graphical representations of internet architecture.

2 Method

Data were collected through semi-structured interviews, a common method in preconception research (e.g., [2]). Participants, 59 pre-service and novice in-service primary school teachers (Table 1) from 10 Czech universities (average age ~24 years, 56 female), were asked to draw their concept of internet architecture and describe their drawings. These drawings are the focus of this analysis.

Recruitment was conducted via Facebook groups for teachers and snowball sampling, with participants receiving approximately 20 EUR. Data collection took place online via Zoom, each session lasting about 60 minutes, following a structured interview protocol. The drawing task was introduced with: *"If we could see the whole internet from a bird's eye view, how do you think it would look? What would it look like from a technical perspective?"* Follow-up questions were adapted to participants' drawings (e.g., *"Does it have any parts?"* or "*What did you just draw?")*.

The interviews were transcribed and analysed using inductive thematic analysis [1] with Atlas.ti 22 by two independent coders. This paper focuses on the drawings and associated responses; full interview analysis will be part of a larger study. The research was approved by the university's ethics committee.

Pre-service or in-service status and teaching experience	*Number of participants*
Pre-service teacher	**38**
No teaching experience (except pre-service training during university studies)	27
Some teaching experience	11
In-service teacher after graduation	**21**
Teaching for less than one year	5
Teaching for one to three years	16

Tab. 1. Characteristics of the participants according to their teacher training and length of teaching experience.

3 Results

The analysis revealed 12 codes representing either the overall structure (e.g., the internet as a spider web) or specific elements within the images (e.g., the presence of a satellite). All identified codes are listed in Table 2, along with the number of occurrences. Typically, more than one code was identified in each participant's image.

Most participants depicted the internet as a network or connection of two or more devices with an unclear structure and ambiguous components (e.g., Figures 1–3). Some of these representations were described as "spider webs" or "webs of information".

Another significant group of images depicted the internet as an invisible force or signal "radiating" from a source (Figures 4–6). Participants in this group described the

internet as ubiquitous and invisible, originating from a source, which sometimes included multiple sources. In several cases, this source was identified as a satellite (Figure 5).

Codes	*Number of code appearances*
Connecting one user device to another user device	17
"Radiating" a non-specific signal all around with no internal structure	11
Including satellite	10
Including internet center (one to one hundred centers)	7
Including transmitting tower	6
Network with unexplained parts (often spider web)	6
"Earth Globe" covered by some kind of signal	4
The participant refused to draw a picture (only explained verbally).	4
Network with explained parts and their functions (e.g. router, server, user device)	3
Including servers	3
Other extraordinary conceptions	2
Devices without connection	1

Tab. 2. Codes related to participant images depicting the structure of the internet, along with the frequency of each element.

Three participants demonstrated a clear understanding of the internet's structure, closely aligning with how the internet actually operates (Figures 7 and 8). Six participants provided detailed explanations using technical terms such as "server" and "network router".

Four participants depicted Earth covered in an unexplained structure, with one attributing this idea to a movie. A total of 10 participants incorporated satellites into their conceptions (e.g., Figure 5, 10), either as a source of internet connection, a transmission medium, or data storage.

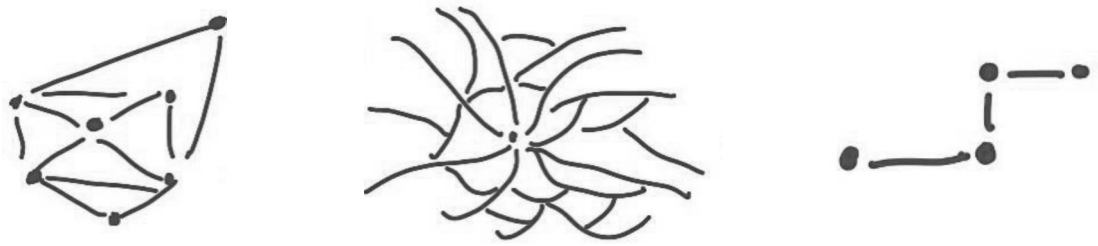

Fig. 1–3. Drawings of participants: Unclear structure or ambiguous components.

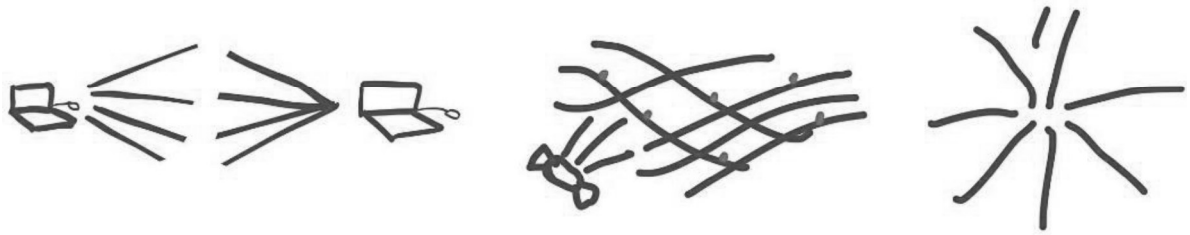

Fig. 4–6. Drawings of participants: Non-specific wave or signal.

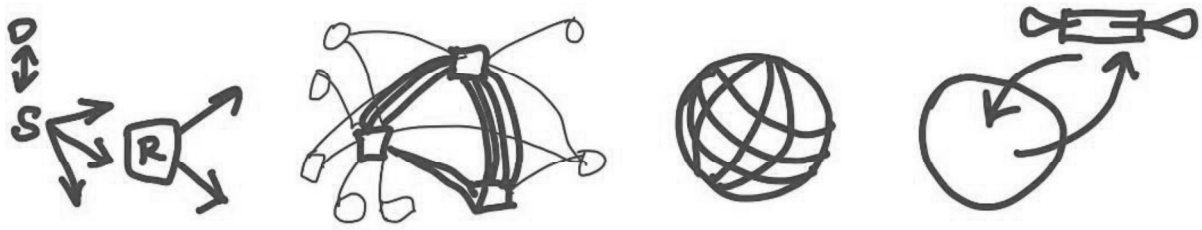

Fig. 7, 8. Drawings of participants: Advanced network. **Fig. 9, 10.** Drawings of participants: "Earth globe".

4 Discussion and Conclusion

This study employed semi-structured interviews and drawing tasks to explore the conceptions of novice in-service and pre-service primary school teachers about internet architecture. Many of the teachers' conceptions resembled preconceptions typically found among children (e.g., the presence of a satellite) [2], though the adult versions tended to be more developed.

For research of this kind, it is important not to rely solely on drawings and brief comments from participants, but to ask additional in-depth questions, which is what we did. These findings hold potential significance for teacher education related to internet functionality.

However, the study has limitations. For example, participants were primarily recruited through social media, and while they were unaware of the specific interview topic, it is likely that they were more engaged teachers. As a next step, it is recommended to develop educational materials to better acquaint teachers with the structure and functioning of the internet.

Acknowledgments. This study was funded by GAUK 484722 and GAČR 22-20771S.

References

1. Braun, V., Clarke, V.: Using thematic analysis in psychology. Qualitative research in psychology 3, 2 (2006), 77–101.https://doi.org/10.1191/1478088706qp063oa. (2006)
2. Brom, C., Yaghobová, A., Drobná, A., Urban, M.: 'The internet is in the satellites!': A systematic review of 3–15-year-olds' conceptions about the internet. Education and Information Technologies 28(11), 1–30. 10.1007/s10639-023-11775-9. (2023)
3. Diethelm, I., Hubwieser, P., Klaus, R.: Students, teachers and phenomena: Educational reconstruction for computer science education. In: Proceedings of the 12th Koli Calling International Conference on Computing Education Research. ACM, 164-17 (2012)
4. Oda, M., Noborimoto, Y., Horita, T.: International Trends in K-12 Computer Science Curricula through Comparative Analysis: Implications for the Primary Curricula. International Journal of Computer Science Education in Schools, 4(4), (2021)