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A Study of Finnish Teaching Practices: How to Optimise Student Learning and How to Teach Problem Solving

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Abstract: This study helps to clarify the teaching practices used by some Finnish teachers to optimise student learning and to teach problem solving. Eighteen teachers (primary through university) from rural, municipal, and metropolitan schools were interviewed to provide insight into the teaching practices behind Finland's successful model of equitable education. Of the eighteen teachers interviewed, nine were asked about how they optimise student learning and nine were asked about how they teach problem solving. Of the nine teachers asked about how they optimise learning, four mentioned practices that align with problem-based learning, and all of the teachers asked about how they teach problem solving mentioned practices that align with problem-based learning. A majority of the interviewed teachers stated that they incorporate individual student competencies and prior experiences into lesson design. All eighteen teachers, regardless of interview topic, mentioned practices related to socio-constructivism as a leading theoretical approach, and all eighteen teachers mentioned motivational practices aligned with the self-determination theory. Finnish teachers have autonomy over their teaching practices so there are teachers who do not teach in the ways represented in this study. Implications of these findings are discussed.

Keywords: equity; teaching; problem solving; problem-based learning; socio-constructivism; self-determination theory; Finland

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1. Introduction

Equity in education refers to students being supported with the resources they need to succeed, whereas equality in education refers to all students receiving the same resources regardless of individual need. The aim of Finland's educational system is to optimise learning for all individuals regardless of age, background, or first language. "A central objective is to provide all citizens with equal opportunities" and that, "the potential of every individual should be maximised [1]".

Teaching practices impact what and how students learn. If students are asked to assimilate information into existing cognitive structures through discovery, learning is facilitated within intentionally designed learning environments that differ from those where students are required to memorise information. According to the Harvard University publication, Education for the 21st Century, "most countries are interested in 21st century skills", focused on "critical thinking, collaboration, creativity, and communication [2]". The Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) measures thinking and problem solving for 15-year-old students [3], and by this measurement, Finland is one of the more successful education systems in the early 21st century.

The PISA compares 15-year-old students' performances in the areas of mathematics, science and reading by nation or geographic area. This international assessment is unique because it focuses on the application of skills and knowledge and presents problems in real-world contexts. One purpose of the PISA is to provide a measurement of students'

overall preparedness for the future, not just their academic achievement [4]. The PISA does not evaluate the acquisition of information per se, but evaluates how learned information is accessed and transferred to solve real world problems. To put Finnish scores into context, the 2009 PISA results from 65 participating countries placed Finland, a small, Nordic nation of approximately five million people, 5th in mathematics, 2nd in science, and 3rd in reading [3]. As a comparison, the United States tied for 31st place in mathematics, was 23rd in science, and tied for 15th place in reading. Sweden, another Nordic nation, placed 26th in mathematics, 39th in science, and tied for 19th in reading. Andreas Schleicher, Director for Education and Skills at the OECD, stated in a 2013 interview that Finnish PISA scores from 2012 revealed that "only five percent of the performance variation in the Finnish student population lies between schools. Every school succeeds. Every class succeeds" [5]. Finland's PISA scores in reading, mathematics and science have since dropped, but in 2018, Finland's median scores remained high and systemic equity persisted; Finnish students' mean scores for science and reading were some of the highest in the world, Finland was one of the world's top performers in reading amongst socio-economically disadvantaged students, girls were top performers in both science and reading, and Finland had one of the lowest percentages of low performers for all subjects (reading, mathematics and science) [6].

This study was inspired by Finland's results on the PISA test, and the purpose of this work is to clarify teaching practices used by Finnish teachers to achieve equity and those used to teach problem solving. The eighteen qualitative interviews in this study were conducted by an American teacher who has more than fifteen years of experience teaching middle and high school students in American schools; the cultural perspective of a non-Finnish teacher interviewing Finnish teachers about their teaching practices provides a unique and practical perspective for cross-cultural learning. It is hoped that the results of this study will assist others seeking to improve educational equity—and student's problem-solving skills—and be inspired to create pedagogical adaptations across geographic and cultural boundaries.

The aim of this study is to investigate the pedagogical methods used by Finnish teachers to optimise learning and to teach problem solving. The research questions will be considered and understood through the socio-constructivist views of teaching, studying and learning, and the self-determination theory.

2. Theoretical Framework

In the socio-constructivist views of teaching, studying and learning, learning is seen as an individual knowledge construction process in which knowledge construction and emotional processes are elaborated via social interactions and the use of language [7]. Learning is viewed as a social, cultural, and motivational knowledge construction process in which experimental experiences, discourse and communication with other people is seen as essential. The premise that students should be active participants in their own learning, and that they should learn to set goals and solve problems independently and together with others, is written in the Finnish national core curriculum [1].

The socio-constructivist approach of learning is interwoven with several theoretical approaches, including Vygotsky's sociocultural theory [8], Piaget's socio-cognitive conflict theory [9] and Bandura's social cognitive theory [10]; the core ideologies of each of these theories are embedded in this study. Learning is seen as a knowledge construction process in which individuals need cognitive conflict created by social interactions with others [9]. The Finnish National Core Curriculum for Basic Education (2104) highlights that learning takes place during these interactions with other students, the teachers, and other adults [1]. Socio-cognitive conflicts create situations where students become conscious of their existing understanding and logic as well as weaknesses in their conceptions; these cognitive conflicts help students to learn to reflect, to communicate, and to negotiate about the knowledge they possess. Furthermore, the core curriculum states that learning together promotes students' skills in creative thinking, critical thinking, and problem solving [1].

When the socio-cognitive conflict approach is considered within the context of social interactions, Vygotsky's sociocultural theory [8] defines learning as a process of higher mental functioning where learning occurs when one is interacting with others and using mediator tools—the tools that one uses to act upon one's environment as well as the psychological tools one uses to control one's own behaviour. The sociocultural theory emphasises the significant role of collaboration and discussion to attain a learners' potential for cognitive learning [11,12]; this is also emphasised in the Finnish core curriculum. Vygotsky's sociocultural theory states that learning is culturally anchored, and that the origin of learning is always created by interactions with more experienced persons [8]. The social cognitive theory of learning is similar, but emphasises behavioural and environmental factors as promoters of a learner's cognitive development and that learning is not achieved in isolation [10]. This approach stresses the view of individuals learning through the observation of models within their learning environments, and that learning is most effective when students monitor and control their motivation and behaviour [13].

The socio-cognitive and sociocultural theories define the socio-constructivist view of learning. In the context of Finnish education, socio-constructivism asserts that meaningful learning occurs when there is collaboration between people and when ideas are exchanged [1]; the focus for the teacher then becomes how to best support these interactions. The Finnish national core curriculum highlights a variety of teaching approaches that should be used in instruction, including the differentiation of instruction in response to students' needs for learning and progression, and the supporting of pupils' self-esteem and motivation; every student has unique needs, interests and talents, and these aspects should be incorporated into lesson design [1].

One of the core components in the knowledge construction process is interest. Interest development is fundamentally important because of its connections to understandings, needs and future adult intellectual pursuits [14]. Understanding a student's willingness to persevere to develop higher order cognitive skills is better understood by examining the internal and external factors driving or thwarting motivation; behaviours that have been robustly studied within the broad framework of the self-determination theory (SDT) [15]. SDT posits that autonomy is satisfied when students take active possession of their learning, they are interested in the topic, and/or they find the assignment has value; competency is satisfied when students work to achieve their own learning goals, and relatedness is satisfied when students feel listened to, cared for and motivated by a supportive environment [15]. A meta-analysis of more than thirty years of research on the SDT revealed the importance of self-determination, its effect on student success and well-being, and how students glean additional benefits of persistence when engaged in activities of personal importance or value [16]. Learning environments that support a student's need for autonomy, competency and relatedness increase student motivation [15], and internal motivation is directly related to student engagement [17,18], a significant predictor of school achievement [19].

For more than forty years, Problem-Based Learning (PBL) has been the focus of substantial research on how to increase student learning through authentic problem solving. PBL requires students to solve relatively unstructured, open-ended problems that cannot be solved with a simple algorithm [20]; these problems trigger student's intellectual engagement and lead them to experience "perplexity, confusion, or doubt [14]" about how to solve the problem. Within these PBL environments, teachers ask students to work in groups to discuss ideas, connect with individual and collective prior knowledge, access outside resources [21], make models [22] and reflect upon possible solutions [8,21,23]. This process of "discussion, problem solving and study" allows alternative solutions to be considered through the social aspects of group work [22]. In PBL, students analyse problems, make models, and evaluate chosen paths of inquiry; individualised learning is increased when teachers provide cognitive scaffolds, ask guiding questions, and provide positive feedback [24].

PBL has been shown to teach students, (1) flexible knowledge, (2) effective problem-solving skills, (3) self-directed learning skills, and (4) effective collaboration skills [21]. PBL

also increases long-term retention of content, problem solving skills, and collaborative skills [20,23,24]. PBL is less effective for achieving short term knowledge and retention [25]. When compared to traditional classroom instruction, PBL can produce equal or superior results for factual learning and for transferring that knowledge to new situations to solve problems [26].

In one study, Finnish teachers reported that PBL promotes "(i) students' or teachers' learning and motivation at school level, (ii) collaboration and a sense of community at school level, (iii) student-centred learning, and (iv) versatility for their instruction [27]." In one meta-analysis, PBL was found to be 86% more effective than traditional instruction in science education [28], and a second meta-analysis found PBL to have a "medium-to-large mean effect size" (0.71) for student achievement, "with stronger effects shown for social science subjects than for science" [29].

Critics argue that PBL is less effective than traditional teaching because it is more efficient to teach students to solve problems in a step-by-step manner [30]. The use of guided inquiry was found to positively affect Finnish student achievement and interest in science, but open-ended inquiry had an adverse effect on student achievement in science [31]. If PBL is presented to students with limited cognitive abilities in an unguided or minimally guided way, it was found to be less effective when compared to directly guided instruction [25]. Wijnia and Schmidt [32] found scaffolding necessary for students to solve problems because scaffolding allows students to work on challenges that align with their abilities without overwhelming their working memory. To determine how to align students' cognitive capacity with problems that require higher order cognitive skills, Tsapsalis and Angelopoulos [33] recommend starting with problems with a lower Z-value (difficulty) and increasing in Z-value as the students progress and gain more experience, keeping cognitive challenges within the student's capacities (X). The use of scaffolding in the problem-solving progression keeps the Z-value within the student's zone of proximal development (ZPD), thereby allowing for the student to maintain confidence as the problems increase in difficulty. If the Z-demand exceeds the student's capacity (X), there is a "significant fall in performance." Students who are able to lower the Z-value by "chunking", dis-embedding information in the problem by filtering out "noise" and identifying important information to be processed, may have less difficulty solving higher-difficulty problems, whereas students with lower cognitive skills will benefit more from mentorship by and socially interacting with more experienced peers.

Socio-constructivism, the self-determination theory, and problem-based learning provide a theoretical background for understanding how people learn and the conditions under which people are motivated. Do these theoretical underpinnings align with Finnish teaching methods, and if so, how?

The following research questions guided this study:

RQ1: What teaching practices do Finnish teachers use to optimise learning?

RQ2: What teaching practices do Finnish teachers use to teach problem solving?

3. Materials and Methods

This study uses a qualitative research design based largely upon teacher interviews, and to a lesser extent, classroom observations and informal discussions. The interviews were recorded and then analysed using Atlas.ti.

3.1. Participants

Eighteen teachers were interviewed from seven rural, municipal, and metropolitan schools and universities in Finland, identified at random, through recommendations by local organisations and colleagues, or unsolicited requests by email. At the beginning, many teachers were cautious to participate; an informal conversation was first conducted and then perhaps a visit to their classroom; this helped build familiarity between the teacher and the interviewer. If the teacher agreed to be interviewed, it was the teacher who chose the time and location. All teachers were given the option to decline to answer questions, to

add any additional thoughts at the end of their interview, and to delete their interviews at the end of the session. No teacher chose to delete their interview. Many teachers stated they enjoyed the interview process and that it encouraged them to think deeply about their teaching practices.

As shown in Figure 1, the teachers were representative of diverse areas in Finland. Ivalo and Utsjoki are in the rural north above the Arctic Circle, Joensuu and Mikkeli are municipalities in the southern and south-eastern areas of Finland, and Vantaa, Espoo, and Helsinki are metropolitan areas in the south. All teachers taught at public schools or at universities. Two schools were in the traditional Sami area of the north and two schools were teacher training schools. Of the eighteen teachers, seven teachers represented metropolitan schools, two teachers represented rural schools, and nine teachers represented municipal schools. The interviews included four primary school teachers (student ages 7–13), five lower secondary school teachers (student ages 13–16), two upper secondary school teachers (student ages 16–18), two lower secondary/upper secondary teachers (student ages 13–18), and five university teachers (student ages 18+). The subject areas represented by these teachers were mathematics (2), general science (1), chemistry (6), physics (4), biology (2), environmental education (1), geography (2), special education (1), music (1), English (1), Swedish (1), Sami language (1), history (1), crafts (1), and physical education (1). Some teachers taught more than one subject and more than one grade level.

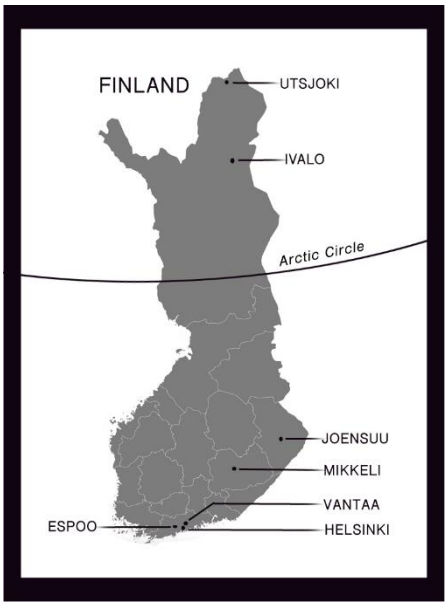

Figure 1. Locations of Interviews.

All Finnish teachers have a master's degree as well as additional coursework in pedagogical studies. The pedagogical studies are focused in two areas—theoretical studies and practice teaching. The theoretical studies include inquiry-based teaching and socio-cultural theory, and all practice teaching courses are held at the teacher training school—except for one course which is held at a regular public school. Because of this training, most Finnish teachers should be well-educated in the theoretical research behind effective teaching and learning and practical teaching skills.

3.2. Data Collection

Data were collected through interviews and driven by the momentum of the conversations. All interviews were related to general teaching practices to optimise student learning (including special education), the teaching of problem solving, and other topics the interviewer found particularly novel or important. The interviewer showed empathetic neutrality, was open to the conversations that emerged, and used follow-up questions

that stemmed from a desire to delve deeper into what the teachers revealed about Finnish teaching practices. The interview process was used as a technique to deepen and clarify each individual's approach to teaching, to support the teacher's reflections on practice, and to reveal each teacher's pedagogical skills. Most interviews took place in classrooms or in the school break rooms or offices. Two of the interviews took place in the teachers' homes. In all situations, the atmosphere was relaxed and conversational.

The researcher as interviewer was a practicing teacher with more than fifteen years of teaching experience in the United States; this provided a unique opportunity to document Finnish teaching methods that have the potential to be adapted to other cultures. Interview questions grew out of the researcher's own reflective practice of teaching, the observations made of Finnish classrooms, and informal discussions with Finnish teachers in break rooms. The researcher did not judge or try to change teachers' opinions. All interviews were conducted in English except for one, which was simultaneously translated into English during the interview by an interpreter. No Finnish teacher spoke English as a first language. Small portions of three interviews were spoken in Finnish and translated later. Interview portions that were translated into English were treated as original sources. All quotes have been written in the interviewed teacher's original voice except when noted. All teachers signed consent forms for their interviews to be researched and published. All interviews were recorded on video with an external microphone. Additional audio recordings were used for back-up.

The interview process provided teachers with the chance to reflect upon their own teaching methods and to expose the details and thoughts behind their individual pedagogical approaches. Meeting face-to-face and approaching these interviews where both sides had questions about the relevance of the information being shared provided the opportunity to delve deeper into why each practice had meaning and importance. The planning for the interviews had to be minimal and flexible, whereas the scheduling, equipment and supportive environment had to be well considered. The evaluation period took time, focus, and many iterations so that patterns of teaching practices with the potential for use/adaptation elsewhere could be revealed.

Classroom notes by the researcher were used to inform and/or supplement interview data when relevant. For example, the researcher viewed student's watercolour pictures on the wall of a lower primary classroom. When the researcher asked if problem solving was used in this assignment, the teacher responded with, "It seems like everything teachers do here involves children in problem solving—even art". This interaction was included in the researcher's notes. During the recorded interview that followed, the teacher was asked to explain how students used problem solving in the making of their paintings. The teacher replied, "In art we did some kind of landscape where there were a lot of trees and a lot of different shades of brown were needed. I didn't give them instructions on how to make brown, but I just gave them a pallet of watercolours. In the watercolour palette there were only blue and yellow and red (paints) and they had to find out how to make brown . . . . (Students) learned, 'I need all three colours.' After that they made (painted) the trunks of trees".

3.3. Data Analysis

All interviews were carefully transcribed, and each interview was considered unique in its nature. The transcribed data were analysed with the help of Atlas.ti software. The analysis of the data was based upon qualitative content analysis (see, e.g., [34]). The analysis started with (1) identification of the teaching practices mentioned in each interview and continued with (2) the identification of patterns revealed across multiple interviews. The iterative process of pattern finding in Steps 2 and 3 meant that each interview was analysed a minimum of five times. Multiple patterns were found while evaluating the text; inductive content analysis was used to reveal a focused view of patterns (cf., e.g., [35]). Sometimes information from informal conversations with the teachers and classroom observations helped to inform the decisions for pattern making. The patterns were then (3) compared to

theoretical background and based upon that (4) the main coding system for the analysis was developed. The categories based on the grouping of the codes were theory based and chosen due to their potential for transfer and adaptability to new educational settings. Finally, (5) the findings were summarised.

4. Results

The purpose of this study was to clarify how some Finnish teachers optimise learning and how some Finnish teachers teach problem solving. The patterns of these discussions are shown in Figure 2 and the number of teachers who mentioned each type of practice is shown on the horizontal axis. The practices mentioned include the consideration of each student's competencies and prior experiences, using open-ended problems, student-directed practices, an encouraging learning environment, activating student interest, student collaborations, teacher support, memorisation, and textbook use. Specific teaching practices like lectures, videos, homework, close-ended questions, research, quizzes, and tests were rarely mentioned, if at all, but this does not mean these practices were never used by these teachers; it only means that these practices were not mentioned by the teachers when discussing the research questions of this study.

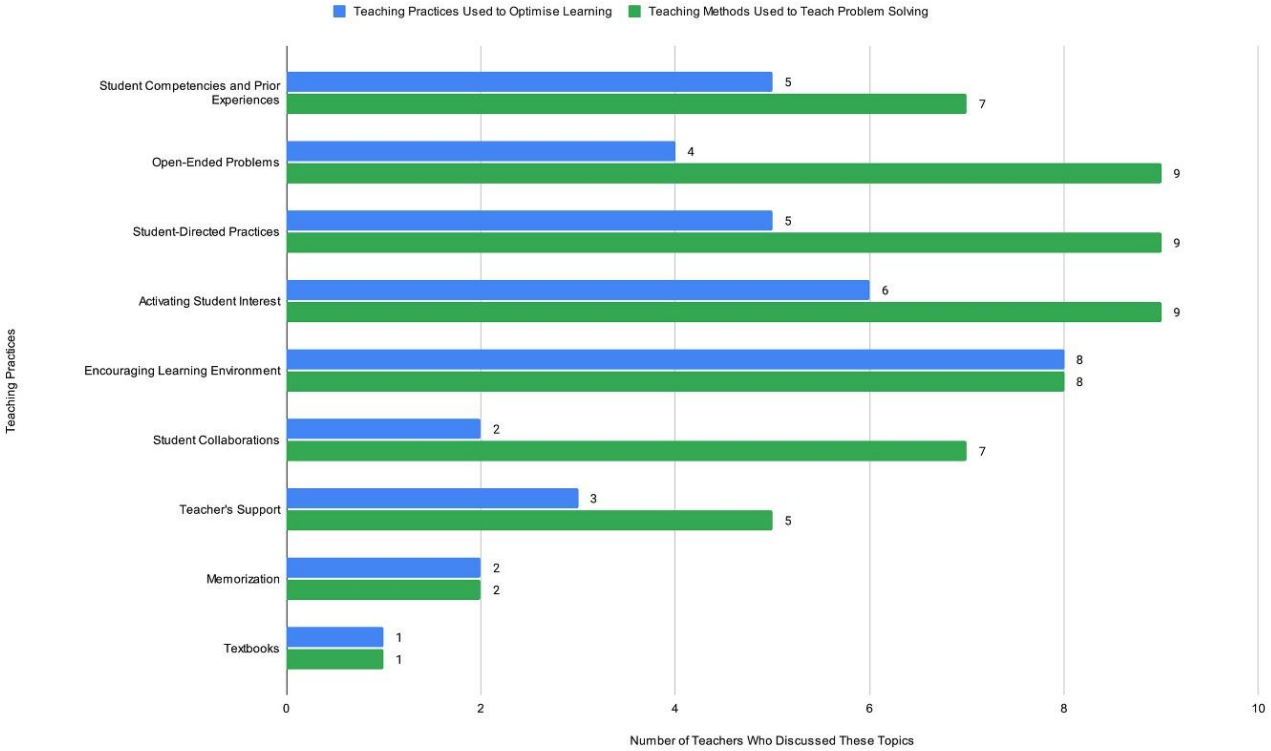

Figure 2. Teaching practices highlighted by teachers during the recorded interviews.

As shown in decreasing order, when teachers discussed how they optimise learning, the teachers mostly referred to an encouraging learning environment, activating student interest, taking into consideration each student's competencies and prior experiences as well as student-directed practices, and open-ended problems. The use of textbooks was the least mentioned practice. When discussing problem solving teaching practices, all teachers in this sample mentioned open-ended problems, student-directed practices and activating student interest. Most teachers mentioned an encouraging learning environment followed by taking into consideration each student's competencies, prior experiences, and student collaborations, then followed by teacher's support (i.e., guiding questions, positive feedback, and scaffolded lessons). Memorisation and the use of textbooks were the least mentioned practices for teaching problem solving. An encouraging learning environment

was pointed out to the same extent for both groups of teachers, and memorisation and textbook use were equally less acknowledged in both discussions.

The practices discussed by the teachers shown in Figure 2 are illustrated with teacher quotes. Teachers who made these statements are identified by a capital letter when discussing optimising learning (A, B, or C, for example), and lowercase letters when discussing problem solving methods (p, q, or r, for example).

The topic of teachers considering each student's competencies and prior experiences helps to answer the first research question—how Finnish teachers work to optimise student learning—and the acceptance of each student's unique abilities and interests was mentioned by a majority of the teachers in this sample regardless of interview topic. Five of the nine teachers discussing how they optimise learning mentioned the importance of each student's competencies and prior experiences, while seven of the nine teachers discussing problem solving mentioned this topic. Some excerpts of the interviews are shown below.

> "We believe that every child has special needs at some point in their learning process. (I)"

> "When they (students) are not concentrating so well one of the main reasons is that they don't have assignments and things that are on their level so I always try to find them levels of assignments so everyone have the joy of finding new things. (k)"

Open-ended problems were mentioned by four of the nine teachers in this study when discussing teaching methods to optimise learning, and nine of the nine teachers discussing how they teach problem solving. The teachers associated open-ended problems with problems that have many potential solutions. Some of these problems took students less than an hour to solve, some problems took several days, and in one instance, it took students more than three weeks to solve. The pace of the teaching responded to the pace of learning and was not determined by a pacing guide. Some excerpts of how teachers discussed the importance of open-ended problems are shown below.

> "(We) give them something that they discover things themselves and it happens in all the subjects. So it's always the starting point. We don't give them anything ready. We make them discover themselves so it could be in art, it could be science, of course, in mathematics, in mother tongue...anything. So it always has to start with getting the children using their brain. (j)"

> "So it's very stupid to give everybody the same (assignment) because maybe there's two children who benefit anything about this training. But if you have some main target to do, everybody learn. (k)"

Student-directed practices were mentioned by five of the nine teachers in this study when discussing teaching methods to optimise learning, and nine of the nine teachers discussing how they teach problem solving. 'Student-directed practices' is a term used here to describe students coming up with potential solutions to a problem, testing their own ideas, and/or having autonomy over finding answers to problems that are either given to them or generated themselves. Teachers pointed out that it was acceptable for students to work autonomously as individuals or collaboratively as a group. Some excerpts of how teachers discussed the importance of student-directed practices are shown below.

> "They must come with some idea and they build in the test the whole phenomenon. (A)"

> "They can use the background they have from chemistry and they can use their skills from home economics and they can mix them and they find the answers and I think they have fun. (D)"

An encouraging learning environment was mentioned equally by teachers in this sample whether they were discussing how they optimise learning or how they teach problem solving. For both groups, eight of the nine teachers mentioned the importance

of an encouraging learning environment. This can be provided by teachers when they encourage student questions, opinions, and different points of view, as well as providing students with positive feedback. An excerpt of how one teacher described an encouraging learning environment is shown below.

> "I try to give them also open doors. I take the simple things with these first steps. I'm not asking them to march in a row. I give them four steps and I give them the free space to do with those four steps whatever they want. (l)"

> "When I build the community in class they can be it's a safety feeling, they can make mistakes . . . . The whole capacity of our thinking, our collaboration, is much higher level than if they just keep repeating. (m)"

Activating student interest was mentioned by six of the nine teachers in this study when discussing teaching methods to optimise learning, and nine of the nine teachers discussing how they teach problem solving. Teachers activate students' interest by connecting the assignment with authentic or meaningful experiences. Some excerpts of how teachers discussed the importance of activating student interest are shown below.

> "When talking about climate change we would normally first talk about the issue at a broad level taking into consideration the economical aspects as well as the socioeconomic as well as the scientific aspects and environmental aspects intertwined with all of these and then look at it from these aspects. (C)"

> "I arrange the learning environments of course it's based on phenomena and I introduce phenomena and then we will be working on what that is about and making this kind of scenario and then we conceptualise it, base it on experimental work. (n)"

Student collaborations were mentioned less: only two of the nine teachers in this study who discussed how they optimise learning mentioned this topic whereas seven of the nine teachers who discussed problem solving mentioned this topic. In collaborations, students work together to discuss potential solutions and/or to solve the problem. Social support provided by peers help to promote learning for all as well as support the feelings of efficacy. Some excerpts of how teachers discussed student collaborations are shown below.

> "They start to work and they have special roles in the group they also might be given or they just form group leaders who report to us and what happens. Usually in science school the teacher is leader for the group, for all the groups, but when they go deeper and deeper on their topic they realise that they know more on the topic than the teacher. (p)"

> "If there is someone who hasn't discovered the correct answer or solved a problem the others are there so it's social constructive way of learning and approaching problems–the others help if there is somebody who doesn't really get it, something so quickly. (j)"

Teacher's support was mentioned by three of the nine teachers in this study when discussing teaching methods to optimise learning, and five of the nine teachers discussing how they teach problem solving. Teachers asking guiding questions, mentoring, tutoring, and coaching students are some examples of how teachers provide support. Some excerpts of how teachers discussed their support are shown below.

> "(Students) should learn some natural way, so children must-at the beginning you give them some problem; they try to solve it. You don't have to tell them exactly what to do all the time. You don't have to say, 'This is the only right way to do (it)!' You just tell them that you show some idea and then they start-try to do it. (k)"

> "Of course, I didn't leave them alone. I went and I tried to help them . . . . I tried to give them support. I guided them to the direction I think might be helpful for them. (l)"

Teachers described memorisation less than other practices—only two of the nine teachers in this study mentioned memorisation when discussing how to optimise learning, and two of the nine teachers mentioned it when discussing how they teach problem solving. Memorisation is used for reaching instructional goals, but it was never mentioned by the teachers except when specifically asked about it by the researcher. An excerpt of how one teacher described memorisation is shown below.

> "Problem solving is better—and memorisation-of course, some of that is needed when you start to learn a language–you need to memorise things, but if you try to solve a problem or want to create something new or in an area where no one has been before then the only skill that is needed there is how to solve the problem that no one has solved before. If you memorise things then it's low level work. (p)"

Only one teacher in each group in the study mentioned textbooks as a tool for reaching instructional goals. One middle school teacher described using textbooks to help higher-achieving middle school science students (who were finished with their middle school work) be cognitively challenged by the high school curriculum. An excerpt of how this teacher described the use of textbooks is shown below.

> "We don't use so much books." a middle school science teacher said. "We just discuss and we try to find other ways. The book is only for the students if they get back home and they are doing homework from there. (I)"

In this study, nine teachers discussed how they optimise learning and nine teachers discussed how they teach problem-solving. Of all eighteen teachers, twelve mentioned the importance of individual student competencies and prior experiences, thirteen mentioned the use of open-ended problems and fourteen mentioned student-directed practices. All but two teachers mentioned the importance of providing an encouraging environment. Fifteen teachers mentioned activating student interest, nine teachers mentioned student collaborations, and eight teachers mentioned providing teacher support.

The type and number of teaching practices discussed by each of the teachers in the study are shown below. Figure 3 shows the practices mentioned by teachers discussing how they optimise learning and Figure 4 shows the type and number of practices mentioned by teachers discussing problem solving.

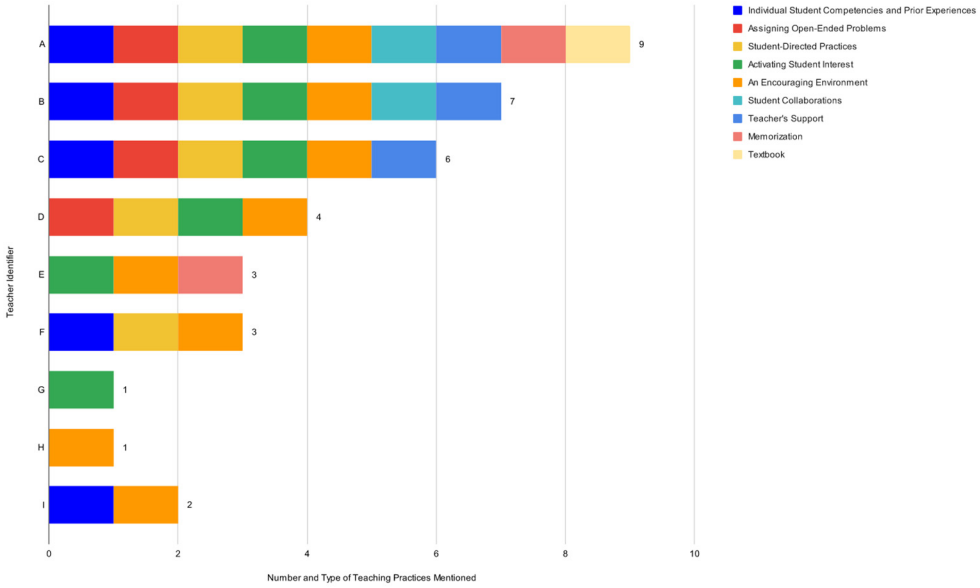

Figure 3. Teaching practices mentioned by teachers while discussing how they optimize learning.

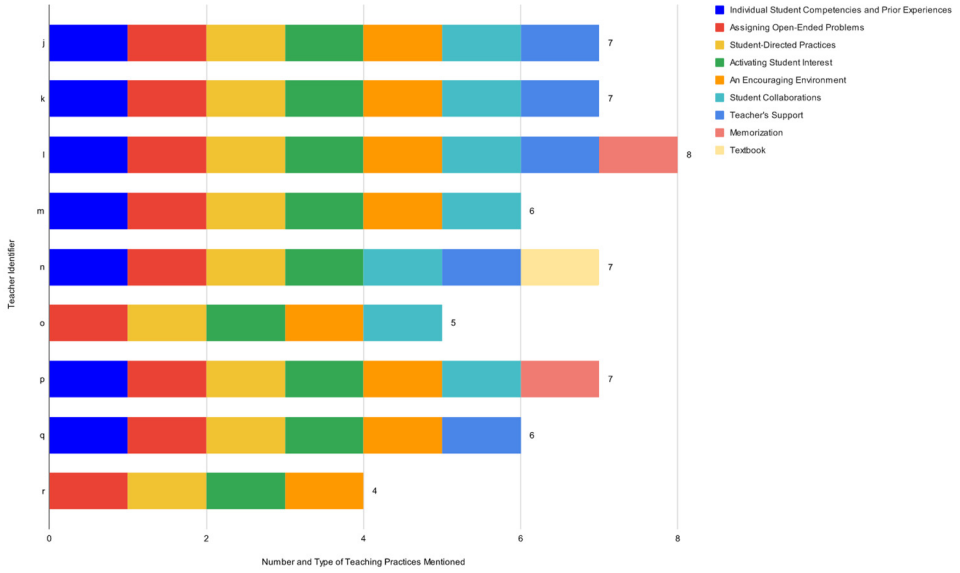

Figure 4. Teaching practices mentioned by teachers while discussing problem solving teaching practices.

Figures 3 and 4 highlight the variety of ways in which Finnish teachers discussed their teaching methods. The two interview questions (optimised learning vs how to teach problem solving) show an even larger variability between groups when analysing the teaching practices. The teachers who discussed how they teach problem solving consistently mentioned more of the teaching practices than the group of teachers discussing how they optimise learning.

Only one teacher who discussed how they optimise learning mentioned nine practices, and not one teacher discussing how they teach problem solving mentioned nine practices. From the teachers in this study who discussed problem solving teaching practices, one mentioned eight of the practices, four mentioned seven practices, two mentioned six practices, and one mentioned five practices.

Table 1 shows teacher practices, how they align with RQ1 (Finnish teachers' practices for optimising learning) and RQ2 (Finnish teachers' practices for teaching problem solving), and how the teachers' responses align with the theoretical frameworks in this study. The first column shows the pedagogical practices identified through the interview process, columns two and three show the number of teachers in each group who mentioned the practice, and the fourth and fifth columns show the potential alignment between the teacher practices, socio-constructivism and the self-determination theory, respectively.

A pedagogical practice is in alignment with the self-determination theory when students take active possession of their learning, they are interested in the topic, and/or they find the assignment has values (autonomy), when students are supported to reach their own learning goals (competency), and the students feel listened to, cared for and motivated by a supportive environment (relatedness). Pedagogical practices that support dialogue between peers and more experienced persons, coming up with one's own ideas, reflecting on one's own ideas, and interacting in a supportive environment aligns with aspects of socio-constructivism. Memorisation and textbook use do not align with either the self-determination theory or socio-constructivism, and both of these strategies were mentioned the least by all teachers. In six of the eight categories, there were more teachers who discussed problem solving teaching practices that aligned with the self-determination theory and socio-constructivism than teachers discussing how they optimise learning. In one category (encouraging learning environment) both teacher groups responded with eight teachers each.

Table 1. Teacher Mentions of Each Pedagogical Practice and the Alignment with the Self-Determination Theory and Socio-Constructivism (n = 18).

Pedagogical Practices	Number of Teachers in This Case Study Mentioning This Practice		Alignment with Socio-Constructivism	Alignment with Self-Determination Theory
	Interview Topic: Optimizing Learning (RQ 1) (n = 9)	Interview Topic: Problem Solving (RQ 2) (n = 9)		
Considering Each Student's Competencies and Prior Experiences	7	5	No	Yes: Autonomy Competency Relatedness
Assigning Open-Ended Problems	4	9	Yes (when collaborating with others)	Yes: Autonomy Competency
Student-Directed Practices	5	9	Yes (when collaborating with others)	Yes: Autonomy Competency
An Encouraging Environment	8	8	Yes	Yes: Autonomy Competency Relatedness
Activate Student Interest	6	9	Yes	Yes: Autonomy Relatedness
Student Collaborations	2	7	Yes	Yes: Autonomy Relatedness
Teacher's Support	3	5	Yes	Yes: Autonomy Competency Relatedness
Memorization	2	2	No	No
Textbook Use	1	1	No	No

5. Discussion

Innovative teaching pedagogies play an integral in the development of student's higher order thinking skills that build upon the natural interests and inclinations of students of "play, creativity, collaboration, and play," and focus on student-centred learning activities that promote engagement and involvement [36–39]. Successful pedagogical practices have the potential to guide international educational research and policy [40] so that people can build the requisite skills needed to solve complex problems such as climate change, sustainable development [41], and the growing disconnect between economic growth and the planet's limited resources [42]. This qualitative study highlights some of the pedagogical strategies used by Finnish teachers to educate its children to be problem solvers [6].

Out of eighteen Finnish teachers, nine were asked to discuss the teaching practices they use to optimise learning, and nine were asked to discuss the teaching practices used to teach problem solving [2–6]. These research questions are considered and understood through the socio-constructivist views of teaching, studying and learning, which aligns with students working in groups and receiving guidance and feedback from the teacher [9,10,13,14]. Most of the practices used by Finnish teachers in this study align with socio-constructivism; these practices include the use of open-ended problems, student-directed practices, activating student interest, student collaborations, teacher's support, and an encouraging learning

environment. Memorisation and textbook use do not align with socio-constructivism, but they are used to some extent, and they do have their place in teaching.

Teachers highlighted teaching practices that include open-ended problems and students solving problems in collaboration with others; this follows the socio-constructivist view of teaching [7]. Teachers did not mention the cognitive conflict [9] that occurs during social interactions, but they did highlight the importance of students working in groups to discuss ideas [8,21–23] as well as students considering alternative solutions through the social aspects of group work [20]. These findings align with sociocultural theory [11] and the concepts of learning as documented in the Finnish core curriculum; students learn by setting goals and solving problems both independently and together with others [1].

Most teachers in this study pointed out that the use of unstructured, open-ended problems [20] within an encouraging environment increases student engagement [14]. This leads to students asking questions, taking actions to solve problems that engage their interests, and negotiating with the teacher about the goals that are reasonable to achieve. Teachers viewed Problem-Based Learning (PBL) as promoting problem solving and self-directed learning (autonomy) [20,28,29]. Learning of factual knowledge and transferral of what they have learned into new situations was not mentioned, even though these features are associated with PBL [26]. Teachers reported that PBL promotes interest, collaboration, student-centred learning, and versatility in instruction, supporting the findings of Aksela and Haatainen [27].

Teachers conveyed PBL as an open inquiry process accompanied by support, whether these problems took one hour, one week, or three weeks to solve. Teachers repeatedly voiced the need to support student's individual needs and the various ways in which this could be provided. Teachers perceived support or tutoring as an essential component of PBL [31] just as Wijnia and Schmidt [32] found it necessary to provide scaffolding within problems so that students can work on challenges that align with their abilities without overwhelming their working memory. Teachers have the potential to decrease the complexity of the content with scaffolds that assist students in the learning process [31] (although scaffolding was infrequently mentioned by teachers) and individualised learning can proceed by providing positive feedback, asking guiding questions to help students analyse the problems, making models, and evaluating chosen paths of inquiry (c.f., [23]). The use of scaffolding in the problem-solving process, if used, helps to keep students in the zone of proximal development (ZPD), thereby allowing students to maintain confidence as problems increase in difficulty [33].

Collaboration was frequently mentioned by teachers discussing how they teach problem solving; this showed teachers' understanding of this aspect of PBL as documented by several prior research studies [23–25,43,44]. Collaborations were discussed in the form of students sharing ideas, students asking questions of one another about their ideas, students reflecting on their own ideas and making compromises so that collaborations can proceed with other individuals, and solving problems together in groups. Teachers most frequently mentioned the importance of creating an encouraging learning environment (encouraging student questions, opinions, and different points of view) and the teacher providing support (asking guiding questions, tutoring, mentoring, and providing students with positive feedback), thereby aligning their approaches with the social cognitive theory of learning and the value of environmental factors for promoting learning [12].

PBL and student-driven practices were mentioned by all teachers in this study who discussed problem solving; most mentioned student collaborations and an encouraging environment, and nearly all mentioned the need to consider the individual competencies and prior experiences [23,24]. Almost all teachers in this study who discussed how they optimise learning mentioned an encouraging environment, more than half mentioned the need to consider the individual competencies and prior experiences of each student, and nearly half of the teachers mentioned PBL, student-directed practices, and activating student interest [24,25]. There were greater differences in consistency when teachers

discussed how they optimise learning compared to teachers discussing problem solving teaching practices.

Teachers acknowledged the importance of student interest and autonomy-supportive teaching, aligning their practices with self-determination and its effect on student success, well-being, and persistence [15,16]. Teachers mentioned seven teaching practices that support student autonomy and self-determination [15,16]: considering each student's competencies and prior experiences, assigning open-ended problems, student-directed practices, an encouraging environment, activating student interest, student collaborations, and teacher support. When teachers consider student's competencies and prior experiences, the potential for creating a caring environment increases as do the opportunities for optimal growth. Assigning open-ended problems as well as student-directed practices increase students' interest and align the assignments with student's values; they also support students working to reach their own learning goals. Activating student interest increases student autonomy [15,16]. Teachers create an encouraging environment by eliciting student questions, asking for opinions, encouraging different points of view, and providing students with positive feedback. Teachers consider it important to ask guiding questions, to mentor, to tutor and to coach. They also shared that student competency is satisfied when students achieve their own learning goals. When learning environments are autonomy supportive [15,16], student's needs for autonomy, competency and relatedness can be addressed and satisfied, thereby increasing student motivation [15], student engagement [17,18] and school achievement [19].

The use of pedagogical practices that align with socio-constructivism (the use of open-ended problems, student-directed practices, activating student interest, student collaborations, teacher support, and an encouraging environment) [9,10,13,14] align with factors shown to drive motivation [15,16] and students' feelings of success, well-being, and persistence [16] (Table 1). Learning environments that align with the self-determination theory and support a student's need for autonomy, competency and relatedness (i.e., considering each student's competencies and prior experiences, assigning open-ended problems, student-directed learning, activating student interest, student collaborations, teacher's support, and an encouraging learning environment) increase student motivation [15], which positively effects student engagement [17,18], success, well-being, persistence [16], and school achievement [19].

Most teachers in this study did not elaborate on how they design scaffolds to increase learning. Most teachers in this study did, however, discuss the unique nature of every student and how learning was dependent upon each student's current abilities and how lessons need to be designed to help each learner achieve optimal growth; this agrees with the approach stated in the Finnish national core curriculum that "A central objective is to provide all citizens with equal opportunities" and that, the potential of every individual should be maximised" [1]. Teachers did not have the expectation that all students attain the same achievements. They did, however, help students set their own learning goals, to solve problems independently, and to solve problems together with others (as written in the Finnish national core curriculum) [1]. A supplementary graphic on how Finnish teachers describe Finnish teaching practices and their alignment with socio-constructivism (and its relationship to student competency) can be found in Figure S1: Finnish Teaching Practices and Socio-Constructivism.

6. Conclusions

This study focused on analysing teachers' teaching practices from the viewpoint of the socio-constructivist view of teaching and learning in which interactions between peers and more experienced persons are seen as significant for learning [7]. The self-determination theory (SDT) was used to consider learning motivation [15]. The Programme for International Student Assessment (PISA) was used to document Finnish educational quality from an international perspective, as well as provide evidence of equity and problem-solving skills for Finland's 15-year-old students [6].

Gaining insight into Finnish teaching success as measured by the Programme for International Student Assessment (PISA) is what ignited the interest behind this research study. A unique and practical perspective was provided by a practicing American high school teacher conducting the interviews. The interviewer asked questions to clarify the pedagogical approaches used by Finnish teachers as they work to optimise learning for all students and as they teach students to solve problems; these interview questions helped reveal patterns in teaching practices that have the potential to be adapted across geographic and cultural boundaries.

The two research questions for this study were to clarify teaching practices used by Finnish teachers to optimise learning and the teaching practices used by Finnish teachers to teach problem solving.

The common teaching practice for nearly all interviewed teachers was to create an encouraging learning environment that valued students' questions, opinions, and points of view. A supportive and individualised learning environment increases students' internal motivation and supports school achievement, as stated in the self-determination theory [19]. Creating an environment where students feel encouraged to learn and build upon their own knowledge may be key for providing the learning conditions where students' skills and internal motivations can be met; the teacher's role must then be to recognise the individualised support that is needed.

This study provides examples of socio-constructivist approaches such as asking open ended questions, using student-directed practices, activating students' interest, student collaborations, teacher support, and creating an encouraging environment [7–11,13,14,20–23]. The role of self-determination—whether that be creating environments that support each student's competencies and prior experiences, assigning open-ended problems, student-directed practices, activating student interest, participating in student collaborations, providing teacher's support, or an encouraging environment—was evident in the majority of teacher responses [15,16]. Teachers did not, however, provide enough evidence for how these practices are put into practice on an everyday basis; this work is paramount for understanding how differentiation is being accomplished for students and how individualised learning is being enhanced. The teachers in this study discussed how these practices are used as part of a blended approach to support students and how it was the job of the teacher to anticipate as well as respond to students' individual needs by providing the necessary support.

This study provides an overview of teachers' practices at different school levels and gives a sample of information about the practical context within which equity can be achieved, and that students with a wide range of abilities can learn to solve problems. That being said, the number of teachers is limited, the practices at the different school levels cannot be compared, and Finnish teachers have autonomy over their teaching, so this study is limited in scope. Teacher interviews at two of the seven schools were taken at teacher training schools where teachers would have a solid understanding of theoretical research and the practices that most benefit learning; this could have had an impact on the number of practices mentioned by these teachers relative to a typical Finnish teacher. There is a need to determine in more detail how teachers approach their teaching practices at each school level. It would also be helpful to know how many Finnish teachers continue to use traditional teaching methods.

From an American teacher's perspective, it was a valuable experience to learn from Finnish teachers and to identify patterns in their teaching practices that have the potential to be adapted elsewhere. Finland's school culture is one where the development of every individual is important, where every child is considered to have special needs at some point in their educational career, and where assignments are designed to maximise every child's potential [1]. Although Finnish education cannot be extrapolated into other cultures, it is hoped that some of the pedagogical practices revealed in this study can provide opportunities for adaptation. Fairness is not defined by providing every student with the same resources, but rather that each student receives the resources they need to succeed.

The teaching patterns revealed in this study show how some Finnish teachers design their lessons so that all students can learn and build their problem-solving skills. Learning in Finland is not rushed, and teaching proceeds at the rate of learning—not at the rate of a predetermined pacing guide. There are very few multiple-choice tests, true/false tests, or any other kinds of tests in Finland. When teachers were asked why they do not test, teachers said they do not need to test; frequent interactions with students provide the necessary information for them to understand how the student is learning, and to follow-up with the cognitive, social, and emotional support students need to continue learning. As immigration increases and more students with varied educational backgrounds arrive in Finland, the scaffolding of lessons may need to increase. Open-ended problems assigned to students who lack the skills or background knowledge to solve these types of problems may be problematic. Additional research on the design and implementation of effective scaffolding may be required.

The Finnish education teacher training program is based upon theoretical research that informs how students learn, and this study, albeit limited in size and scope, provides valuable information for the international community on how to support individual students in their intellectual growth and well-being, and how to support students to become citizens with experiences in idea generation, collaboration, and reflection on how to solve problems. This study has implications for education theory, policy and practice. It also provides important knowledge for policymakers and teacher educators for teaching in-service teachers. These results support the potential of theory-driven education as well as practical steps for increasing educational equity and problem-solving abilities for students both within Finland and across cultural boundaries.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci12110821/s1, Figure S1: Finnish Teaching Practices and Socio-Constructivism.

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