Teaching with Google Classroom: Claimed Usage, Perceived Effects and the Potential for Subject Learning

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The use of digital tools in education is subject to debate in school as well as in wider society. This motivates studies on the potential of these tools to facilitate teaching and learning. One of the digital tools being used is Google Classroom (GC). In order to increase knowledge of its usage and effects in content teaching, semi-structured interviews were conducted with 18 teachers in Swedish compulsory school. The aim is thus to answer three research questions: 1) How do teachers describe their usage of GC in teaching? 2) What effects of using GC do teachers perceive? 3) How can GC be used to develop students' communicative and metacognitive abilities? In the interviews teachers primarily described usage of GC as structuring, but also with some pedagogical objectives. Teachers also reported on perceived effects on students' motivation to learn and development of knowledge and skills. In summary, the interviews indicate teachers' different degrees of appropriation of GC and opinion on its affordance.

We conclude that GC has a potential to promote students' learning, but that teachers may need training and support to take advantage of that potential.

Key words: Affordances, Appropriation, Education, Google Classroom, Subject learning

1. Introduction and Literature Review

Digital tools in education are widely debated in media. In columns and on social media strong opinions are expressed, and many are the persons who consider themselves knowledgeable about whether digital tools benefit or disadvantage students and their learning. The debate is polarised, and often revolves more around what tools should or should not be used than on how they are actually used in education. Calls for banning digital tools in schools are heard in the debate while students all over the world are becoming increasingly more digital and live parts of their lives online. The way people consume, create and communicate has been changed by digital tools (Granitz & Koernig, 2011). Banning them in education seems impossible in a digitised society, but a critical approach is necessary.

Previous studies in the area have been performed mainly on distance or blended higher education, while only few studies concern digital learning and teachers' views at lower educational levels. The current study thus explores the use and possible effects of digital tools in compulsory school teaching.

The overall goals and guidelines expressed in the Swedish curriculum (Skolverket, 2018) state that:

> The school is responsible for ensuring that each pupil on completing compulsory school …
> can use both digital and other media for attaining knowledge, processing information,
> problem-solving, creation, communication and learning; … can learn, explore and work both
> independently and together with others, and feel confident in their own ability" (Skolverket,
> 2018, p. 11-12)

The guidelines express a view on knowledge acquisition which resonates with the description of knowledge exemplified by Rennie (2005) regarding knowledge of science: "knowing science as a way of thinking, finding, organizing and using information to make decisions". The guidelines indicate that teachers in Swedish compulsory school are expected to use digital tools to not only

structure and organise teaching, but also to promote learning in the aspects of communicative and metacognitive abilities. One digital tool that is commonly used in Swedish school is Google Classroom (GC). GC is used internationally and was introduced in Sweden in 2014. In this study teachers were interviewed with the aim to gain knowledge about how they use GC in their teaching for 10-16-year olds and what effects are perceived. The intention of this study is thus to increase knowledge of the potential of GC to facilitate teaching and learning at the lower secondary school level.

The research questions are:

RQ 1: How do teachers describe their usage of GC in teaching?

RQ 2: What effects of using GC do teachers perceive?

RQ 3: How can GC be used to develop students' communicative and metacognitive abilities?

In the following we give an overview of central concepts and previous studies of GC usage and its effect, as well as a theoretical background this study.

1.1 Google Classroom as a mediational means

GC is a cloud-based and platform-independent tool that can be used in different settings and at different levels of education. GC is connected to the Google Drive and can be used to structure and handle the flow of communication in the physical classroom. Each classroom created within GC is referred to as a virtual classroom (VC).

The VC is created and owned by one or more teachers and can be activated and deactivated by owners. The VC can be created for a course or a subject, but also for a specific purpose, e.g. students' personal reflection. Published posts are instantly available for users and owners registered to the VC.

At the time of the study the following features were available in GC:

1. Announcement – one-way communication of hyperlinks and files, connected to Google Drive, YouTube and the computer's filing system.

2. Question – two-way communication of messages which require some sort of response.

3. Assignment – communication of assignments with an optional deadline, connected to Google calendar. Assignments are submitted digitally and automatically organised which gives owners/teachers an overview of the status of each assignment. Assignments can be assessed and released to the student for resubmission. This process can be repeated. The features enable owners and students to post comments visible to all users in connection with all boxes. Owners can remove individual users from the VC. All features also allow students and teachers to interact.

1.1.1 Studies on Google Classroom usage and effects

So far most studies concerning GC and its impact on the learning situation have been conducted in distance or blended higher education. One example is a study that investigated instructors' usage of and attitudes towards GC (Iftakhar, 2016). Through interviews teachers mentioned the possibility for asynchronous ("anywhere-anytime") teaching as a benefit and claimed that GC promotes collaborative learning and instructor-student interaction. Results from the study show that teachers' professional ICT development and positive attitude towards the tool are crucial for a successful implementation (Iftakhar, 2016). Another study examined usage of GC to find factors that affect the degree of student engagement in E-learning (Abazi-Bexheti et al., 2018). A total of 937 courses using GC were analysed using a web-based analysis tool. Usage was categorised using a model inspired by proposed LMS usage levels (Janossy & Hover, 2008) which was adapted to GC and has four levels from level 0 (no usage of the tool) to level 3 (advanced usage of the tool). Results from the study indicate that students were more prone to collaboration and showed a high level of GC usage if teachers encourage student participation (Abazi-Bexheti et al., 2018). Both these studies thus emphasise that the use of GC can effectively support collaborative learning among university students. This resonates with the findings of Kyoko et al. (2017). In their paper the authors assert that the use of GC may positively impact on student collaboration in elementary school as well, thereby offering possibilities to promote engagement among students.

Not least GC's support for asynchronous learning has been pointed out as a factor that can affect students' learning situation (Northey et al., 2015). In higher education stimulating asynchronous learning was found to have the potential to promote students' engagement and agency (Umbach & Wawrzynski, 2005). Furthermore, Heggart & Yoo (2018) examined how pre-service student teachers studying the ethics and philosophies of education evaluated their own and their instructors' usage of GC during the course. The authors conclude that:

> It is important to recognise that the tools are not an end in themselves; rather, their use fostered collaboration and increased agency and voice amongst students, attributes which were seen as desirable in this subject and which would, we imagine, be equally desirable in other subjects. (Heggart & Yoo, 2018, p 151)

In summary, the study shows the importance of teachers promoting 1) accessibility, 2) collaboration, and 3) student agency to facilitate students' learning.

Further, Di Cicco (2016) examined the effects of using GC on knowledge and skills in a group of six grade 7 students with learning disabilities who used learning material posted in GC for self-paced studies. Students collaborated only while doing online quizzes. The results showed that vocabulary scores for the majority of the participating students increased, and that three of the six students showed increased scores on knowledge acquisition of subject concepts.

Altogether, the different studies indicate that the usage of GC can create conditions for promoting student collaboration, engagement, agency, vocabulary skills, and possibly also conceptual understanding. Apart from the positive impact that the usage of GC can have on student learning, earlier research has also identified challenges. For example, some of the preservice student teachers in the study mentioned above found the rapid flow of content in the GC overwhelming (Heggart & Yoo, 2018). According to the authors this calls for conscious structuring of the content in large GC student groups. Another challenge concerns students' individual computer work. Working without teacher guidance increases the risks for distraction by social media and games, and may impact negatively on results (Hatakka et al., 2013). Teaching that promotes teacher-supervised and computer-mediated individual or group work on the other hand may lead to a higher degree of student satisfaction, and to improvement in student results (Grönlund et al. 2014).

1.2 Sociocultural perspective in this study

According to the theory of sociocultural learning, learning takes place in a social context, and that interactions with others influence the individuals' learning (Vygotsky, 2001). Learning is mediated by artefacts or tools (intellectual and material) that can stimulate development in the specific context. In that context, learning takes place in a dialectic relationship between the subject, the object and the context, aided by mediating resources (Säljö, 2013). The individual and the context are inseparable and by using mediating tools in a specific context the individual becomes an active agent (Daniels, 2008, p 9). It is therefore impossible to separate the effect of tool usage from the individuals who use the tool; they are individuals acting with a mediational means (Wertsch, 1998).

The basic unit of agency is defined as "individuals-operating-with-mediational-means" (Wertsch et al., 1993, p. 352). This implies that a mediating tool can create, or distribute, as well as constrain, the opportunity for the individual to carry out new cultural activities with the mediating tool. Agency is achieved as a result of previous experience, projective and the perceived possible activities of the tool, but also of the setting: "rather than seeing the agency residing in individuals, agency is understood as an emergent phenomenon of actor-situation transaction" (Biesta et al., 2015, p. 626). Teachers and students can be considered to be agents when interacting with the digital tool in education, and agency depends on what is perceived by agents as possible activities and how the tool is appropriated.

1.2.1 Appropriation

Säljö (2013) discusses how individuals appropriate new tools (Figure 1), where appropriation starts with a user's initial contact with the tool when testing it with external support, and is completed when the user masters the tool in a specific context and for a specific purpose and it has become a part of the user. This indicates that for teachers of different subjects the appropriation process too may differ. In this perspective teachers' appropriation of an educational tool can have implications for students' appropriation and agency in learning in different ways in different subjects.
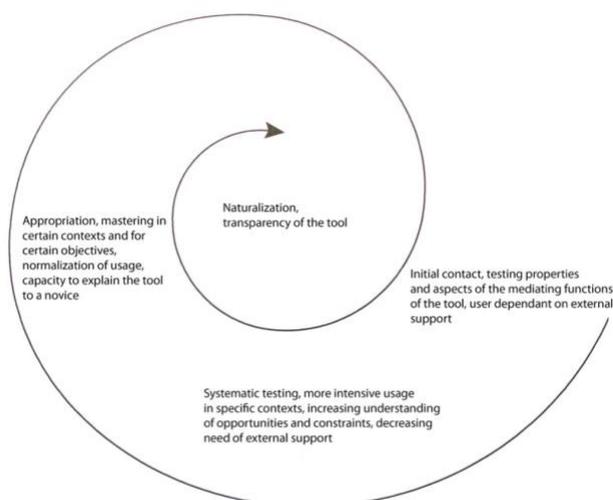
Figure 1. Appropriation according to Säljö (2013, p. 230).

1.2.2 Affordances

When individuals appropriate a tool, the achieved agency depends on what activities the user perceives; the *affordances* of the tool. The concept of affordance originally described animals' dependence on perceiving the threats and possibilities their surroundings offer (Gibson, 1979). Accordingly, Gibson introduced the concept of affordance to describe the complementary of the animal and the environment (p. 127). He described affordance as dependent on the capacity of the user. Norman (1988) applied the concept to human-technology interaction and argued that the design of technology can act as affordance or constraint for fruitful interaction and claimed that when we encounter new, more complex objects, we use previous experience, training and instruction, *mental models*, to help us perceive possible actions.

Gaver (1991) continued the discussion and described four dimensions depending on whether the affordances can be perceived or not. *Perceptible affordances* can be perceived and acted upon, *false affordances* are perceptible but cannot be acted upon, *hidden affordances* are possible to act upon but are not perceptible, and *correct rejections* cannot be perceived nor acted upon. These distinctions are significant in the design of complex objects and artefacts, such as digital resources. Gaver (1991) states that: "the role of a good interface is to guide attention via well-designed groups of sequential and nested affordances" (p 82).

Digital resources, such as GC, are laden with affordances which offer certain technical and pedagogical possibilities in a specific context, perceived by users to varying degrees according to their technical and pedagogical ability (Thapa & Hatakka, 2017).

2. Aim and Research Questions

This study investigates how teachers of various subjects describe usage and effects of using Google classroom in their teaching. According to the Swedish curriculum subject learning outcomes also comprise generic attributes (Skolverket, 2018). This could be exemplified by some of the learning outcomes in the science subjects which include students' ability to communicate the subject in different ways and contexts, and for different purposes including the purpose of own learning (p. 168–169). Teaching in biology/chemistry/physics should:

- give pupils opportunities to use and develop knowledge and tools for formulating their own arguments and examining those of others in contexts where knowledge of biology/chemistry/physics is of importance…
- contribute to pupils developing the ability to discuss, interpret and produce texts and various forms of æsthetic expressions with scientific content.
- essentially give pupils the opportunities to develop their ability to use knowledge of biology/chemistry/physics to examine information, communicate and take a view on questions concerning health, natural resource use and ecological sustainability / energy, technology, the environment and society / energy, the environment, health and society.

While being learning outcomes, as such, students' communicative and metacognitive abilities are also significant to higher levels of understanding. As described by the SOLO taxonomy (Structure of the Observed Learning Outcome) these higher levels of understanding for example assume students' ability to argue, criticise, and explain causes (*Relational level*) and hypothesise, reflect and theorise (*Extended abstract level*) (Biggs & Collis 1982). This makes students' ability to articulate and reflect upon subject matter as well as their own understanding of it key to their development of higher subject understanding. The aim of the study is thus to explore how GC may possibly facilitate subject learning, and especially aspects of communicative and metacognitive abilities.

3. Method

This qualitative study was conducted in Swedish schools from a sociocultural perspective, with focus on mediated action in a cloud-based digital educational tool, Google Classroom (GC). In the community where this study was performed web-based resources were used for communication, assessment and grading when Google Applications for Education (GAfE, later Google Suite for Education) was introduced. Previous introductions of new digital resources had been carefully implemented while the introduction of GAfE and GC professional development initiatives was left to the local school leaders. Not all schools offered this professional development and as a result a number of teachers started using the Google tools without any local training. This study includes some of those pioneers who also continued to use GC in their teaching.

3.1 Selection

Highly able teachers who had used GC since the Swedish release of the tool and who were still actively using GC in their teaching were interviewed to collect the information needed for this study. What was considered to be a high ability was not defined beforehand. The objective was not to limit the selection to a certain subject or type of usage, but rather to find a wide scope of usage which would benefit the study.

Selection was performed within the municipality by reaching out to a) members of an ICT-teaching network organised by the central administration, and b) a network of municipality school leaders, to receive suggestions on teachers who met the requirements. An e-mail invitation was sent out to all 25 suggested teachers. One teacher declined participation and six teachers did not answer in spite of an e-mail reminder. The remaining 18 teachers agreed to participate.

At the time of the study the interviewed teachers taught students aged 10-16 years in a variety of subjects and were considered by themselves and by others to be able users of GC. They all initiated their usage of GC when it was launched in Sweden in 2014 and had continued using it on a regular basis. Since the study is not intended to evaluate GC, but rather to find a wide range of usage, this requires the researchers to find examples of usage in utterances and see beyond what interviewees expressed as affordances not acted upon. Participating teachers have been categorised according to their teaching and experience (Table 1). Gender is not considered a category of interest to this study.

Table 1. Coding and organizing of participating teachers by 1) subject taught, 2) number of years in the profession and 3) age of students taught using GC

Teacher code	Subjects taught	Years in the profession	Age of students
A	Science studies[1], social sciences[2], mathematics, arts	9	10-13
B	Science studies[1], mathematics, arts	17	10-13
C	Science studies[1], Swedish, SL Swedish[3], English	18	10-13
D	Science studies[1], Swedish	3	10-13
E	Science studies[1], mathematics, technology	8	13-16
F	English, Swedish, SL Swedish[3], social sciences[2]	15	10-13
G	English, Swedish	6	13-16
H	English	15	13-16
J	English, Spanish	16	12-16
K	Swedish, SL Swedish[3]	10	13-16
L	Social sciences[2], Swedish	16	10-13
M	Social sciences[2], Swedish	9	10-13
N	Social sciences[2]	20	13-16
O	Social sciences[2]	10	13-16
P	Social sciences[2], Swedish	16	13-16
Q	Arts	14	13-16
R	Home and consumer studies, English	8	13-16
S	Home and consumer studies, physical education and health	8	13-16

[1] *Biology, physics and chemistry*

[2] *Civics, geography, history and religion*

[3] *Swedish as a second language*

3.2 Data collection

Data collection was performed as semi-structured interviews with the aim of collecting rich descriptions of teachers' experiences. Kvale & Brinkmann (2009) discuss the semi-structured interview as a method in between an ordinary conversation and a questionnaire, suitable for capturing personal experiences. The questions should focus on certain themes, and can be considered as suggestions, to be changed by the interviewer according to the situation. Questions in this study were chosen with regard to the research questions, and were used for all respondents to allow for finding common themes between answers. To get a rich description, examining and sequential questions were asked. Interpreting questions were used to facilitate interpretation. Interviews were conducted at the respective workplace of participating teachers, to avoid inconveniences for interviewees. The main interview questions were used as a guide for all interviews:

- Why do you use GC?
- How confident do you feel using GC?
- How do you use GC?
- What choices do you make when using GC?
- What effects do you perceive from using GC in your teaching?

All interviews were performed by the same researcher between April 2016 and April 2017. The interviews lasted between 15 and 44 minutes and were recorded digitally for verbatim transcription. Pauses and non-verbal communication were not noted in transcripts. Interviews and transcripts performed in Swedish but meaning-bearing utterances were translated into English to reflect the initial meaning. Since respondents have not been observed, results will not concern actual classroom usage but rather expressed perceptions about usage and effects.

3.3 Data analysis and categories of usage

The empirical material consisted of transcribed interviews analysed using content analysis, a method suited for making valid inferences from texts emerging from a specific context (Cohen et al., 2011). The analysis aimed at finding utterances where teachers described usage of GC in their teaching and what effects were perceived using GC. Utterances regarding usage were categorised using a deductive approach and organised according to levels determined by Abazi-Bexheti et al. (2018), described in table 2. Steps between the different levels are characterised by increasing support for activities that require and develop student's communication, interaction and responsibility for learning. This reflects the progression of students' understanding and agency described by the SOLO-taxonomy (Biggs & Collis, 1982).

Utterances regarding perceived effects of using GC have been categorised using an inductive approach. Themes, categories and subcategories were found through the following process:

- One of the researchers listening to recorded interviews, reading transcripts and noting interesting utterances related to the research questions. Noting keywords for further search.
- Digitally searching transcripts using keywords to find evidence related to the research questions. Examples of keywords used are *collaborative work*, *group work*, *assessment, effect*.
- For each interview question, labeling utterances in the transcripts and organising utterances into related themes, and in accordance with the usage levels (Abazi-Bexheti et al., 2018, p. 33–34).
- All three researchers thoroughly reading transcripts in order to develop categories and codes describing content of teachers' utterances. A process of constant comparison (Cohen et al. 2007; Miles and Huberman 1994) was used on the compiled utterances to identify, discuss and verify themes and categories at three different stages of the analysis until consensus was reached.

Identified categories of perceived effects are described in table 6.

3.4 Ethical considerations

This study was performed in accordance with guidelines established by the Swedish Research Council (2017). The interviewed teachers were presented with the purpose of the study, and informed about their participation and the opportunity of ending their participation without any explanation. All interviewees gave written informed consent to contribute to the study. Participating teachers and their references to persons or places were anonymised and coded to avoid identification.

4. Results

All respondents started using GC at the time of the Swedish launch 2014 and had used it for more than 18 months at the time of the study. This section presents participants' utterances about their claimed usage and perceived effects from usage.

Teachers' descriptions showed a positive attitude towards GC, and described their usage of GC, i.e. the VC, as organised either in subject-oriented structures, or shared by two or more teachers of different subjects.

Table 2. Teachers' GC activities categorised according to the usage levels described by Abazi-Bexheti et al. (2018) and exemplified by activities described in the current study. The number of teachers describing each usage shown in brackets

Level	Description	Examples from this study
Level 0	No GC usage	
Level 1	Teachers using GC for uploading documents and posting assignments Students using GC for downloading materials and submitting assignments	*Structuring usage:* *- Linked resources (16)* *- Course/lesson plans, assessment criteria (10)* *- Demonstrating examples[1] (7)* *- Teaching material (5)* *Pedagogical usage:* *- Assignments (18)*

		- *Extended/challenging tasks (6)*
		- *Individualised tasks (4)*
		- *Self-recorded material (4)*
		- *Individualised VCs (3)*
Level 2	Use of communication and assessment tools, such as quizzes and surveys	- *Formative assessment (14)*
		- *Students' self-evaluation and reflection (7)*
		- *Exit tickets, summative tests, quizzes (4)*
Level 3	Advanced use of GC such as recording lessons and implementing pedagogical features beyond the basic functions of GC	- *Teacher-initiated peer-learning and group interaction in documents and files (13)*
		- *Flipped classroom (8)*
		- *Teacher-initiated peer response (7)*
		- *Digital student portfolios (3)*
		- *Lesson documentation (3)*

[1] *Examples showing learning goals to students*

4.1 Claimed usage of Google Classroom

The 18 teachers described their usage of GC in teaching. Descriptions were categorised after the interviews using the levels introduced by Abazi-Bexheti et al. (2018), shown in table 2. Teachers' claims reflect variation among individuals regarding how and for what purposes GC is used. They also indicate that there may be differences between the subjects. For example, it could be worth noting that all science teachers describe using GC on all three levels, which is not the case for any other teacher in the study. The second note is that in particular science and language teachers promote group interaction in digital documents. In the following teachers' claimed usage is summarised and exemplified for each of the three levels.

4.1.1 Level 1 usage: Uploading and downloading

Table 3. Teachers' level 1 usage of Google Classroom

		Subjects taught																	
		Science[1]					Language				Social studies[2]						Art & crafts		
	Activity/ Teacher:	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S
Struct-uring usage	Linking learning material	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X
	Course and lesson plans		X		X	X	X	X		X			X	X			X		X
	Teaching material		X				X	X							X			X	
Peda-gogical usage	Assignments	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Extended tasks	X	X			X					X				X			X	
	Individualised tasks		X			X					X	X							
	Self-recorded material			X		X			X					X				X	
	Individualised VCs					X							X	X					

[1] *Biology, chemistry, physics*

[2] *Civics, geography, history, religion.*

From the analysis of teachers' utterances two discernible sub-categories – structuring usage and pedagogical usage – were identified on level 1. The first sub-category refers to posts aimed at structuring and organising teaching and learning, such as course and lesson plans, goals and assessment criteria, while the second sub-category comprises posts with a pedagogical objective, such as assignments, self-produced recordings, student examples and extended tasks for students who need additional challenges (table 3). Therefore, the model by Abazi-Bexheti et al. (2018) has been complemented with these two sub-categories on level 1 (table 2). Posts described as having a pedagogical objective or required interaction by students, beyond downloading, were categorised as pedagogical usage. Thus, posting a lesson plan, which does not require any further activities by the student was categorised as structuring usage, while posting an assignment, which required a student reaction, such as writing and, in some cases, submitting, was interpreted as pedagogical usage.

Level 1 usage required mainly one-way communication, with the exception of assignments which were expected to be returned in some, but not all, cases. All teachers described level 1 usage.

4.1.2 Structuring usage

Sixteen teachers structured their teaching by linking resources to a VC to increase support for students' individual work. J found this to make students' work more efficient: "They are more likely to find information [this way] than if I serve them books". One teacher expressed how linking learning material through GC had removed the need for traditional workbook: "I don't use a workbook. Instead I use a collection of links … and students are given their assignments in GC" (R).

Ten teachers described posting plans and documents aimed at supporting course structure, i.e. course and lesson plans, learning goals, rubrics for assessment and assessment criteria for the specific course or subject: "They can find … the assessment criteria and how they can prepare at home and what is expected from them" (F). Several teachers also published plans for single lessons or parts of courses.

4.1.3 Pedagogical usage

The assignment feature was the only one all teachers claimed to use. Published assignments receive a separate box where teachers add titles and instructions and link resources depending on the purpose/objective. Students may submit files of documents, pictures, audio or video. Written assignments was the most common type, but the interviews showed a rich variety: "The assignments can be anything from reading to answering questions or if they are to watch a film and reflect upon it" (D). F claimed that the opportunity to add a title and structure to assignments helps to clarify objectives: "It encourages the teacher to put an effort into describing what is actually expected". The comment and assessment features are described in more detail in "Formative assessment in Google Classroom".

Nine teachers discussed individualization by adapting material and assignments to students' circumstances and needs. At the time of the interviews the option to address posts to specific students was not available. Nonetheless a number of teachers individualised material and assignments to support students' in attaining the goals of education: "In specific student's assignments I remove a couple of questions or rephrase the assignment" (G).

A challenge that teachers claimed was addressed by using GC was the need for more demanding tasks for high-achieving students: "It is fairly easy to adapt an assignment to make it challenging … and this is appreciated by high-achievers" (G). Another teacher described instead how assignments should be sufficiently open: "It is up to the teacher to give assignments to fit everyone" (R). One teacher claimed that the features in GC did not allow for individualization, and yet another argued private information or assessment for security reasons should be performed in the central assessment platform: "That's why I don't publish any individualised assignments aimed at specific students" (N).

Self-recorded material was posted by five teachers. O described using self-recordings to support students with special needs: "We record questions using Screencastify [screen and microphone recorder] … and the student [with dyslexia] also answers the question in a self-recording". Three teachers described addressing special needs by assigning personal VC with supporting material, e.g. audio files, for specific students.

4.1.4 Level 2 usage: Communication and assessment

Level 2 usage adds two-way communication and using GC for tests, assessment and evaluation. Out of the 18 teachers 15 described level 2 usage, as seen from Table 4. Teachers described using tests, quizzes and exit tickets. Formative assessment such as feed-back/feed-forward comments and usage of posted rubrics was also described.

Table 4. Teachers' Level 2 usage of Google Classroom

Teacher:	Subjects taught																	
	Science[1]					*Language*				*Social studies*[2]						*Art & crafts*		
	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S
Formative assessment	X	X	X	X		X		X	X	X	X	X		X		X	X	X
Self-evaluation and reflection				X	X	X		X								X	X	X
Exit tickets, summative tests, quizzes		X				X			X					X				

[1] *Biology, chemistry, physics*

[2] *Civics, geography, history, religion.*

4.1.5 Formative assessment in Google Classroom

Thirteen teachers described using comments through GC for formative assessment with the objectives of supporting students' work during and after the finished work process: "Since I can peek into students' work [I can easily] support those who need it" (C). Some used this two-way communication to support students' learning process: "They submit, I comment and return it and

ask them to develop, and they resubmit" (B). Comments on students' work were written in the actual document and in the private comment box.

One teacher recorded individualised formative assessment as an audio file which was returned to the students within the document they were working on: "I record my assessment and post the link as a private comment in the document, and they can do the changes and resubmit" (H).

Rubrics for assessment were used to support a dialogue about learning. While most teachers claimed to publish rubrics as a one-way communication some teachers used them in teacher-student dialogues: "[Students] mark where they consider themselves to be at ... and we have a discussion based on that" (S). Participating in students' work process was described as time-consuming, but A experienced a reduced workload at the end of the process: "Almost all the work on assessing disappears at the other end". One teacher claimed not to publish rubrics for assessment to avoid doing unnecessary work: "We have the assessment portal for much of our assessment, so I don't want to counteract that" (O).

4.1.6 Students' self-evaluation and reflection
Teachers described how they would use GC for students' teacher-initiated self-evaluation and reflection in relation to both learning criteria and individual goals. They report using the question feature for different purposes: "It can be a thought, a reflection, simply an evaluation of something or to reflect on their personal goals" (E). Students were asked by F to reflect on their learning by finding previous tasks in GC to combine their answers in running text, or to reflect on their answers regarding a specific concept.

4.1.7 Exit tickets, summative tests and quizzes
GC was used for different tests, but also to promote students' work, for example with self-correcting tests in Google Forms to help students detect their proficiency level: "[Students can] analyse 'was this the correct level for me' ... and then do the exercises". These teachers saw summative tests as a part of students' learning, to help students develop the intended learning outcome and enable teachers to monitor it. With the use of Google Forms, F claimed to ask

students to document their progress in reading as an exit ticket and collect the results: "Within minutes … we can show the answers in a pie chart".

4.1.8 Level 3 usage: Advanced use of GC

Level 3 usage exceeds the basic features of GC, and examples found in this study are shown in table 5. Documentation of lessons with digital photographs are also categorised as level 3, following Abazi-Bexheti's et al. (2018). Fifteen of the 18 teachers described usage that could be referred to level 3.

Table 5. Teachers' level 3 usage of Google Classroom

Teachers	Subjects taught																	
	Science[1]					Language				Social sciences[2]						Art & crafts		
	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S
Teacher-initiated peer interaction	X	X	X	X	X	X	X	X	X			X	X	X				X
Flipped classroom	X				X	X			X	X		X	X					X
Digital student portfolios		X[3]														X		X

[1] *Biology, chemistry, physics*

[2] *Civics, geography, history, religion*

[3] *B teaches science and arts and claimed to use GC for student portfolios in arts*

4.1.9 Teacher-initiated peer interaction

GC allows students to interact in the questions feature, in the class comment fields, and in documents which also have a chat feature. Thirteen teachers described actively promoting peer interaction. For four teachers this was the only level 3 usage. According to F peer interaction had increased students' engagement in group work: "[GC] is a boost for group work". Peer interaction

also encouraged students in their learning process: "There is always [a peer] online ... so they can post questions and be pepped (A).

G described how absent students used the chat feature in groups: "[They] actually join [in the shared document] ... and chat their way onwards". Several teachers also claimed to promote the development of quality peer response through GC.

Students' abuse of interaction opportunities was discussed. E and S found that having a large number of students in the same VC could inspire abuse. As a consequence, students' opportunity to comment in GC was limited: "We have at times shut this feature off for those who used the chat improperly" (S). This limited students to interacting with only the owners of the VC, but students chatted outside GC, for example through the Google Drive.

Teacher F used the question feature to promote student interaction: "We use the question feature openly to let students take part of each other's answers depending on the objective". Interviews show differing experiences regarding peer interaction in GC. While some teachers promoted and facilitated interaction, others prevented it.

4.1.10 Flipped classroom

Eight teachers described using GC for flipped classroom assignments. E described posting a self-recording as a flipped classroom that caught positive attention: "I recorded myself and posted as a 'flip' ... I got a lot of response from that, and many submitted assignments". Some described posting films for students to watch and others combined it with an assignment.

4.1.11 Digital student portfolios

Using GC as a student portfolio where students for documentation of the process and self-assessment in different ways was only described by teachers of practical subjects, e.g. "[Students] write their training journal and continuing self-reflections regarding their progress and the noticed results" (S). Some teachers were also active participants and described usage as characterised by student activity and teacher support in the process.

4.2 Perceived effects of Google Classroom usage

Teachers described perceived effects for both students and teachers (Table 6) but some argued that it is not the application GC in itself that affects the learning situation, it is a matter of pedagogical skill: "It is the combination of a practical tool and a good teacher" (N). F claimed that GC adds new possibilities: "You can do things you couldn't before, to make learning visible". G confirmed this and expressed the risk of using GC only to replace non-digital elements: "If I only use [GC] as a substitute for pen and paper I won't get anything more out of it".

This section analyses teachers' utterances on perceived effects of using GC in their teaching (table 6).

4.2.1 Accessibility, structure, clarity and reduced stress

Increased accessibility, structure and clarity were the most commonly mentioned perceived effects related to structuring usage. Five teachers expressed that accessibility led to reduced feelings of stress among students and that teachers and students spent less time searching for lost documents: "Instead of searching for things and getting frustrated ... students can start working and learning instantly" (B). Some teachers described a connection between structure and learning: "I believe that [structure] affects clarity incredibly, and hence learning" (E). Clarity was described in terms of expressed teaching goals, learning criteria and course/lesson plans which according to G reduced obstacles for struggling students: "They become more easily started, and perhaps reach understanding faster". One teacher, on the other hand, found GC too complicated for struggling students: "I think that it is super simple, but often it does not work for [struggling students]" (M).

Table 6. Teachers' perceptions on effects of GC usage

	Subjects taught			
	Science[1]	Language	Social studies[2]	Art & crafts
Teachers	*A* *B* *C* *D* *E*	*F* *G* *H* *J*	*K* *L* *M* *N* *O* *P*	*Q* *R* *S*
Accessibility	X X X	X	X X X X	X

Structure		X	X		X			X	X	X		X	X	X	X	X	X	X
Clarity			X	X	X	X	X	X		X		X	X	X	X	X		X
Reduced stress	X	X		X			X				X							
Visualised learning		X	X		X	X	X	X	X	X	X				X			X
Awareness of learning	X	X	X						X									X
Student motivation	X	X	X	X	X	X		X	X				X				X	
Student activity		X			X	X	X	X			X		X	X	X		X	X
Student agency	X	X	X		X	X	X		X	X		X					X	X
Student collaboration			X			X	X	X		X				X			X	
Perceived presence		X	X		X		X	X										

[1] *Biology, chemistry, physics*

[2] *Civics, geography, history, religion*

4.2.2 Visualised learning, awareness of learning and student motivation

The learning process was described as more visible to students and teachers: "We can access [students'] thoughts in different topics along the work process" (F), which was believed to promote students' metacognitive ability according to the curriculum subject learning outcomes (Skolverket, 2018). Learning was also visualised as a result of the assignment interface: "[their work] becomes the basis for assessment without me hunting them down" (E).

Structure was also claimed to increase motivation, hence disengaged students were more likely to execute and deliver their tasks on time: "It is easier for them to get started, do the assignment and submit it" (F). Some described how students were more motivated to engage in a dialogue about their learning: "They know what they have to do, what is expected from them and where they are supposed to be ... then their curiosity increases along with the ambition to do things" (F). We note that all participating science teachers (A-E) experience an increase in student motivation. Teacher M had noticed an initial increase in motivation but claimed that it had worn off: "It is starting to get more everyday now". No other teacher expressed the same experience.

4.2.3 Student activity and student agency

Many utterances described how students were more active in combination with the opportunity to backtrack earlier work. F also claimed that since struggling students are more active with GC than before, it is easier to monitor their learning process: "You have access to more of their thoughts and ideas". According to a group of teachers connecting the VC to the calendar also made students more active: "They plan their learning from the calendar" (O).

Some teachers described how students' agency affected the development of their metacognitive abilities: "Students log on, check rubrics and follow checklists constantly". (S). G had observed how students recaptured what they missed during absence: "If you've been absent a week you can actually find all the information you need online", and missing fewer specific elements was believed to positively affect students' learning. Four of the five participating science teachers described an increase in student agency in learning.

Teacher F has been described as a teacher who created innovative teaching methods in GC, and who focused on promoting students' metacognitive ability: "It's ... about seeing GC as a way for students to know that they are not alone ... they can support and help each other". This teacher's classroom emerged as a place that promoted student agency for learning with a clear subject-oriented objective.

4.2.4 Student collaboration

Seven teachers emphasised the advantages of using GC for collaborative student work. H described how students benefited from collaborating when doing listening exercises: "[Struggling students] feel more included ... and stronger students grow with the task". P had students do group summaries and noticed them sharing their results with each other: "Suddenly they were the ones who shared something [instead of the teacher]".

Another effect was increasing collaborative assessment, where teachers jointly administered specific VCs. Teacher-initiated peer response had also led to quality peer response: "When [the students] assessed each other's work, the peer comments too were formative" (C). R had previously observed how students divided work among themselves instead of collaborating in groups but using GC as a tool for group work had changed the conditions: "They access each other's [writing], share ideas and comment along the way". R also claimed that the opportunity for real-time collaboration facilitates asynchronous work: "If students are absent they can still continue working, because everyone has access". The opportunity to monitor group work led to fewer conflicts connected with group work: "There is not as much fuss in group work as there used to be" (S).

Not all teachers considered GC to afford group work, and some expressed the need for features that allow for creating groups in the VC to facilitate communication of group information. One teacher also expressed a view of learning as a group process, and therefore deemed GC unsuitable for group work: "GC sometimes goes in the opposite direction when all students dive into their own classroom and get stuck there" (C).

4.2.5 Perceived presence

GC allows teachers to follow students' work in real time in the assignment and to support the learning process from anywhere, which was perceived as a strength. One teacher who had been absent yet active on GC described how the students reacted: "I sense that students actually appreciated [my commenting] ... because they wrote me questions 'how do we go on from here'" (A), as if the teacher were present in the classroom.

J had monitored students' work during a sick leave and learned from the substitute teacher that students appreciated it, and L described how this asynchronous work could motivate students: "They know that I monitor, that I see their learning".

H used recorded annotations to comment on student work, and described how students appreciated hearing their teacher's voice: "[Students say] 'It's almost as if you were with me at home'". C had received feedback from parents who had noticed their interaction with students outside of school hours: "[Parents say] 'You have quite a commitment to your students'". Descriptions show how GC was used as a mediating tool which allowed asynchronous interaction. Through GC students felt the teacher's presence as if it were synchronous, which made them more committed.

4.2.6 Perceived effects in different subjects

Teachers' perceptions regarding effect of GC usage are essentially similar in different subjects, though they differ in some aspects (Table 6). Responses from participating science teachers (A-E) show that they all experience an increase in student motivation, and that four of them claim students show increased agency in their own structure and learning. An increase in students' awareness of their own learning was discussed by three science teachers, as was reduced student stress. Only one science teacher claimed that GC usage had resulted in an increase in student collaboration, while all language teachers were of the same opinion, though all the science teachers claim to promote collaborative work in digital documents. A plausible explanation could be that science subjects are usually taught in interactive environments, where students collaborate (Jakobsson et al., 2009) and this circumstance is not changed by the usage of GC.

4.3 Summary of the results

Teachers' expressed usage of GC is summarised and categorised in Figure 2 according to Abazi-Bexheti et al. (2018). Among the teachers four described only 3-5 different types of usage. On the other hand, four teachers described 10-11 types of usage, some beyond the basic features. Twelve teachers described usage on all three levels, three described no level 2 usage while three others described no level 3 usage.
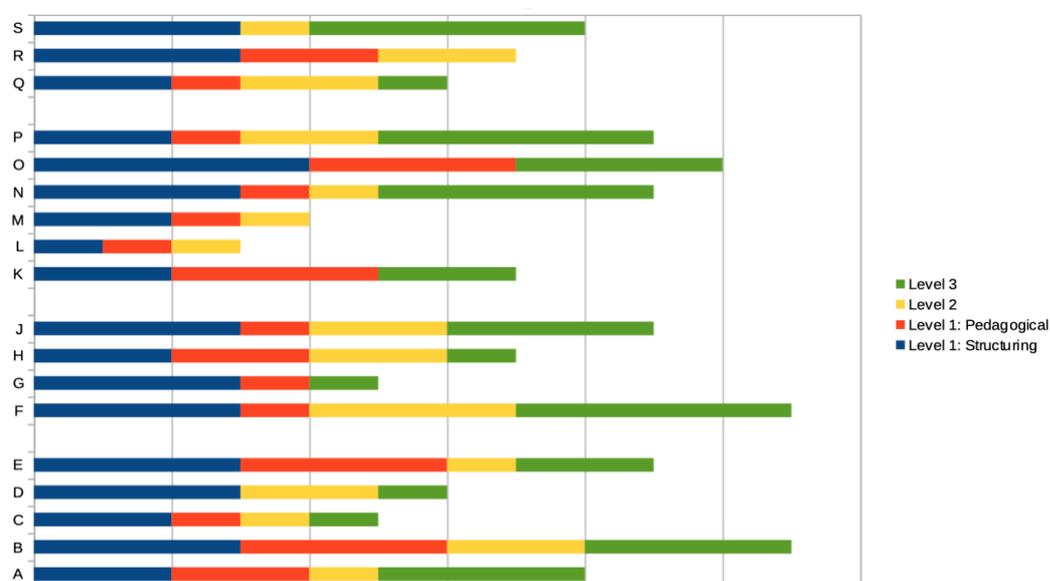
Figure 2. Summary of teachers' claimed usage of GC categorised by usage levels (Abazi-Bexheti et al., 2018). Teachers A-E taught science (Biology, physics, chemistry), F-J Language, K-P Social science (civics, geography, history, religion) and Q-S Arts&craft.

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The main perceived effects of using GC were connected with structure and organization (table 6). Communicating goals, plans and learning material increased structure, clarity and accessibility, which in turn had led to increased student activity and motivation, and in some cases also to reduced stress. Students' motivation was described to be positively affected when students experienced teachers as present even if they were not. Hearing and seeing their teacher through GC activities, yielded a high degree of student motivation and agency. Examples of such activities were teachers' self-recorded flipped classroom lessons, but also voice-recorded formative assessment, and teachers engaging in students' digital documents out of school hours.

Though teachers often work long hours grading and assessing students' work, traditional pen-and-paper assessment does not make students experience their teachers' presence. Although one teacher claimed that the increased motivation initially perceived had started to wear off, most teachers claimed that the effects were still affecting both students and teachers.

Many of the respondents expressed that formative assessment had increased. There were also effects from pedagogical usage, for example when individualization had reduced obstacles for struggling students. Furthermore, teachers claimed that communicative abilities were positively affected by students collaborating in different ways, sharing documents and jointly working on specific assignments. Teachers also described how students' metacognitive abilities developed as they engaged in dialogues regarding learning, making learning visible and finding ways to use the digital tool to plan their learning.

5. Discussion

In this study experienced teachers were interviewed about their use of Google Classroom in their teaching and what effects they perceive from the usage. The study also aims to explore how GC can be used for developing students' communicative and metacognitive abilities.

GC affords a rich diversity of actions, perceived to very different degrees by the 18 teachers interviewed in this study. In fact, teachers described opposing views on some of the affordances of GC: Some teachers expressed that GC does not afford group work while others claimed that it had become "a boost for group work" (teacher F). Some teachers deprived students of the possibility to interact through GC, and yet others claimed to promote student interaction through GC. Some of the teachers described how GC mainly affords structuring and one-way communication, while others described how it affords a number of innovative teaching methods and thus promoted interaction beyond GC's basic features.

The various utterances regarding usage illustrate how some teachers, despite being considered highly able users, and themselves claim to be confident users of GC, have appropriated GC to different degrees and types of usage for different purposes. These different purposes could be related to different levels of student understanding according to the SOLO-taxonomy (Biggs &

Collis, 1982), but also to the aims of the Swedish curriculum regarding the development of communicative and metacognitive abilities (Skolverket, 2018).

The results reflect that for some teachers, possible actions were hidden affordances (see e.g. Gaver, 1991), while for others the same actions were perceptible and had brought new possibilities to the classroom. The discrepancies also illustrate differences in individuals' appropriation processes as discussed by Säljö (2013, p. 232). While some teachers rapidly master a tool in a specific context, others need more time and practise, and a few might never reach beyond the initial levels of appropriation. GC offers such a large variety of possibilities that no teachers will be able to make use of all. However, with experience and support, teachers are more likely to expand their usage repertoire in a way that reflects the idea of progression contained in the model of Abazi-Bexheti et al. (2018).

That teachers often focus mostly on structuring usage, rather than supporting students' ability to collaborate when using digital resources in teaching was found also in an earlier study (Malmberg, 2006). However, a few of the teachers in our study reported on more varied usage, which also supported collaboration. Regarding the impact of using GC, teachers' reports on perceived effects included increased student motivation, action and collaboration (table 6). Students were reported to engage in teacher-initiated interaction, but some teachers also claimed to have experienced how students were more prone to student-driven collaboration, even to the extent that when restricted from interacting through GC they found other ways to stay connected to their peers. When engaging in group work, students were perceived to collaborate to a higher extent than teachers had previously experienced, and with less group conflicts. We cannot know with certainty whether these effects were really obtained, since we are restricted to teachers' descriptions. However, from the many independent and consistent utterances, it is reasonable to assume that the teachers' perceived effects reflect the actual outcome. In summary, the reported effects indicate that GC has the potential to promote students' development of communicative and metacognitive abilities as well as agency for learning. These are all abilities expressed as aims for teaching in the Swedish syllabi (Skolverket, 2018). Teachers claimed that communicative abilities were positively affected by students collaborating in different ways, sharing documents and jointly working on specific assignments. The benefits of collaboration for the development of students' writing skills have

been described e.g. by Dysthe, Hertzberg, & Hoel (2002, pp. 128, 145), and Vygotskij (1987) has emphasised the cognitive effects of verbalising and communicating subject matter.

Using GC to facilitate interaction and communication could hence be a way for content teachers to support students' development of communicative abilities as well as a deepened understanding of the content.

Some of the interviews highlighted how students' metacognitive abilities developed as they engaged in dialogues together with their teachers regarding learning, made learning visible and found ways to use the digital tool to plan their learning. The teachers' utterances thereby illustrate how agency for learning was affected when students were joining in asynchronous work with teachers and peers, and when students took more responsibility for their own learning, even when absent from school. Similarly, in earlier work concerning higher education Umbach (2005) found that asynchronous learning and blended learning positively influence students' engagement and agency. As described by Lederman et al. (2013), students' agency means an ability to engage in discussions and be prepared to act on knowledge achieved through teaching and learning. Exemplified in a science education context this meaning of agency resonates well with how scientific literacy has been described: "knowing science as a way of thinking, finding, organizing and using information to make decisions" (Rennie, 2005). We thus conclude that using GC as a tool for asynchronous and blended learning in science education could offer a way to support students' learning of science and development toward scientific literacy, and in other subjects, correspondingly, learning of the subject and development of disciplinary literacy.

Key factors for success when implementing digital or blended learning, as identified in earlier studies, are promoting a) accessibility, b) collaboration and c) agency (Heggart & Yoo, 2018), and d) asynchronous work (Northey, 2015). Teachers in this study also expressed that conscious usage of GC allows asynchronous access to students' work for teachers and peers. Teachers can access students' work for assessment and dialogue, stimulate students' motivation and agency and facilitate collaboration. While some teachers promoted this, others described organising their virtual classrooms in ways that constrained collaboration and agency for example by shutting off interaction features, and other teachers integrated too many students in the same virtual classroom.

These findings support claims by teachers who express a connection between the features of the tool and the teacher's pedagogical proficiency.

Interviewed teachers were considered skilled users of GC but described differing perceptions of the affordances of the tool, which had been used for up to18 months at the time of the interviews. Thapa & Hatakka (2017) suggest that these differing perceptions may be explained by users' varying technological as well as pedagogical ability. Having an interest in integrating technology in teaching is not enough when it comes to implementing GC in the classroom. Most teachers in this study focused on structure and organization, while other used the resource to effectively support students' communicative and metacognitive abilities and agency. With a pedagogical focus in digital professional development on using a digital tool in education this gap may be narrowed.

5.1 Conclusions

Altogether, this study has shown that GC has the potential to be a powerful mediating tool when used consciously and with pedagogical objectives. The major conclusion is that the functions of GC can benefit students' learning and agency for learning. A prior condition for that development is the teacher's ability to use the affordances of GC pedagogically and consciously align the tool with the syllabus and the learning goals in their subject. Our findings imply that teachers of different subjects may experience different affordances and challenges associated with using GC, although the limited data in this qualitative study do not allow for drawing any general conclusions. A second conclusion is that teachers may need support along the appropriation process in order to facilitate that development. We thus call for further studies on how teachers can advance their digital proficiency to be increasingly subject-oriented and to promote agency when teaching.

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