

Authentic Teaching in STEM Education – factors for success version

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ABSTRACT

Teaching for authentic learning is described in the literature as motivating. Therefore, some schools in Sweden profile their education as authentic and some teachers strive for such teaching. During 2022, in a case study, we followed teachers and students in grade three with an age of 17-18 years, in a technology programme at a secondary school with the aim to explore specific patterns in characteristics in teaching for authentic learning. The result showed that teaching in a technology programme in an upper secondary school can be done with characteristics related to theories. Some patterns stood out as enablers of authentic teaching. Firstly, it seemed to be important to start early with authentic activities when the students begin their first year. Secondly, the teachers must let the planning, teaching and assessment "go out of control". The present work concerns a follow up study with a broader participation. Data was collected during interviews with six teachers in different schools, both primary and secondary schools. All teachers had participated in specific courses and were involved in projects dealing with teaching about space in STEM, with an authentic approach. The interviews were analysed both related to a category system based on theories about authentic learning as well as more thematic. The aim was to explore what patterns appeared as enablers of authentic teaching.

Key Words: Authentic teaching, STEM education, technology education

1. INTRODUCTION

The literature describe how teaching should be designed for authentic learning (e.g., Herrington & Oliver, 2000; 2010; Rule, 2006; Hill & Smith, 2005), with the goal of developing students' understanding of complex issues like climate change (Cross & Congreve, 2020). Authentic assignments provide a real-world context (Rule, 2006; Resnick, 1987; Young, 1993; Harley, 1993), in which students can apply their knowledge and reflect on their learning (Rule, 2006). The learning environment should be open, with opportunities for students to consult with experts (Collins et al., 1989) and encounter different perspectives. The tasks should be complex, and assessment should be integrated into activities (Herrington & Oliver, 2000). Rule (2006) describes how important it is, in authentic learning, that students, in addition to being allowed to

work situationally on a real-world problem, also get to face real challenges with their task and thereby develop their thinking and acquire new knowledge. When students are taught using an authentic learning approach, they must encounter "wicked problems" (coined in Rittel & Webber, 1973) and authentic ways of working, such as group work and debating, in a way that highlights the complexity of tackling these issues (Herrington & Herrington, 2006; Pitchford et al., 2021, Lönngren, 2021, Peters & Tarpey, 2019).

The present work concerns a follow up study where we studied what emerged in teachers' descriptions of their teaching for authentic learning. The aim was to explore what patterns appeared as enablers of authentic teaching.

2. THE THEORETICAL FRAMEWORK FOR THE STUDY

In our previous work (Engström & Lennholm, 2023) we studied what characterizes teaching for authentic learning and, above all, what enables it. We chose to apply the principles of authentic learning that Herrington & Oliver (2000) and Herrington et al. (2010) have developed, presenting them as "nine guiding design elements":

- (i) Provide an authentic context that reflects the way the knowledge will be used in real life,
- (ii) Provide authentic tasks and activities,
- (iii) Provide access to expert performances,
- (iv) Provide multiple roles and perspectives,
- (v) Support collaborative construction of knowledge,
- (vi) Promote reflection to enable abstractions to be formed,
- (vii) Promote articulation to enable tacit knowledge to be made explicit,
- (viii) Provide coaching and scaffolding,
- (ix) Provide for authentic assessment of learning.

What emerged in the study and appeared to be important for enabling teachers to allow students to work authentically was that teachers must dare to let go, relinquish control over the teaching, planning and assessment (Engström and Lennholm, 2023). In addition (and arguably the most crucial factor), they must have the full support of the management as well as back-up resources. The fact that the school's teaching can confidently implement the authentic method was largely explained by the management's support in respect of contacts, skills and resources, acceptance, and self-assurance.

The present follow-up study was conducted with the aim of listening to more teachers about how they work for students' authentic learning and why, as well as what enables their teaching. The same theoretical framework for what may characterize the teaching was used; the "nine guiding design elements" by Herrington & Oliver (2000) and Herrington et al. (2010).

3. METHODOLOGY

We conducted interviews with teachers with subsequent thematic analysis (Braun & Clarke, 2006). The analysis was conducted partly as a deductive thematic analysis using Herrington and Oliver's nine guiding elements, and partly as an inductive thematic analysis aimed at finding patterns in teachers' statements related to what enables authentic learning. Six natural science- and technology teachers, teaching at all levels of primary and secondary education, were individually interviewed for about an hour. The group contained both male and female teachers, all of them had a least 15 years of experience in teaching. The teachers all work at different schools, scattered across Sweden. All teachers are involved in a teacher council related to space and STEM – with an authentic approach, in which it becomes clear that they have an interest and experience in teaching for authentic learning.

The questions asked and discussed were: What examples of authentic themes have you taught? Describe what was taught and how the students worked. Can you describe how you think about such teaching? What is important and how do you assess it? What do you think is important for you to teach for authentic learning? Why do you think you do it and want to do it?

The interviews were conducted digitally and recorded. They were transcribed and analysed thematically. The aim was to find themes related to what characterises teachers' described teaching related to the nine elements, as well as what enables and otherwise characterises teachers' teaching. Before the interviews started, the teachers were informed about the purpose of the study, that it is voluntary to participate, that their names, schools, etc. will not be made visible, and that we handle recordings according to research ethics and data storage rules at our institution.

4. RESULTS

The research question was: What emerges in teachers' descriptions of their teaching for authentic learning? The different themes that emerged in the teachers' statements related to what characterize their teaching for authentic learning and what enables it. We found four themes:

- Dare to let go,
- Strong leadership,
- Need for contacts
- View on teaching in the subject.

We also present results about how the teachers' descriptions of their teaching relate to the nine guiding elements presented in Herrington & Oliver (2000) and Herrington et al. (2010).

4.1. Themes that describe teachers' teaching for authentic learning.

In teachers' descriptions and positions, four different main themes emerged related to what characterize their teaching, strategies, and personalities. For each overarching theme, different aspects that showed both similarities and differences in strategies and positions came to light.

4.1.1. Dare to let go!

This theme was evident for all teachers in the study, and they wanted to highlight the ability or personality that is important for the teaching approach to authentic learning to be possible. They recounted the importance of "daring to let go" to make authentic learning possible.

"It's about me daring to let go".

They outlined how the teacher needs to "dare to not know" everything and also show it to their students. When students ask questions, teachers must have the confidence to show their ignorance and their willingness to find answers together with the students. The teachers described this as "letting go," "letting go of control." It seems to be an ability that they believe sets them apart from other teachers.

"Other teachers see it as extra work."

"A lot of it is that the teachers are afraid to do things that you don't feel you can master yourself, instead of thinking that the children can."

Teachers emphasised the importance of being unpretentious and daring to trust oneself.

"I don't know the answer and I have to be confident in saying it...today you get to find out the answer, it's not me who knows...then we'll find out!"

4.1.2. Strong leadership

The teachers also emphasised the need for strong leadership to implement teaching for authentic learning. They reported how leadership can be described with three different meanings: the teacher's own strong leadership/mandate or that the school leadership actively supports, but also that the teacher has a soulmate, a partner who supports and collaborates.

Some teachers clarified that they themselves have power, they have obtained a mandate by being a first teacher or lecturer. They may be the one who has worked the longest, longer than the principal, and in addition, the role of subject responsibility gives them status and a strong mandate. They are listened to a lot depending on the power position they hold as a first teacher or subject responsibility, etc.

"It has meant that I've had a lot of contacts... I'm the one they come to and ask if there's anything".

"I'm the kind of person who makes sure I get to do what I want."

"I've been at my school for 25 years, so I know everyone, and everyone knows what I'm doing."

For other teachers, the importance of having the ear of the management was evident. They described that the management engages in their proposals, allowing them to implement their ideas. They can get the school management on board and obtain resources.

"They are so open and there has been money and when we went to the technology lift, they asked if there was something we wanted."

"We get a lot of praise both from our principals and from the administration...it feels like it's appreciated."

Another way to develop and feel strong leadership is for teachers to have a colleague at their own or another school with whom they can collaborate. It provides strength and self-confidence that can be translated into empowerment and thereby status. Teachers described how they could feel a little lonely about their approach to work in their own school but can plan and implement their ideas and thereby develop empowerment in their own school through a colleague at another school.

"We have taken half a day during the summer holidays to co-plan. A collaboration with another person who is passionate in the same way is so developing".

"I get some [colleagues] with me, I have a colleague at the middle school, he often takes over the students that I have had. We connect with each other".

4.1.3. Need for contacts

A prominent theme in teachers' descriptions of something that enables their teaching for authentic learning was that they create and have created contacts outside the school. One characteristic is that teachers search broadly to make study visits, to collaborate, to have meetings with different people, to make visible different actors in society. It can involve very different actors: local radio and daily press, museums and science centres, authorities and companies, politicians and experts of various kinds, universities and various industries, etc. Teachers described how, depending on what emerges in teaching, they are prepared to search widely for collaboration partners or actors outside the school.

"Then X, my colleague and I discussed, how are we going to get this project out... then we started talking about the local radio and then we contacted them."

However, some teachers clearly take a position on who and with whom to collaborate. For example, private companies were considered not to have a place in schools. In such cases, there are criteria for who to contact. Universities, government agencies, and municipalities were considered suitable. The argument was that private companies should not have an impact on schools.

"I would like to have contact with a research institute, but I don't think we should involve private companies in the school. It is more of a matter of principle".

On the other hand, other teachers emphasised entrepreneurial skills as fundamental and believe that it is rewarding for students to encounter private initiatives and both small and large companies. Such encounters can serve as inspiration. Similarly, these teachers believed that local businesses could contribute to schoolwork, including being a future employer for students.

"I think that the part that is still in our curriculum that you should try to work with companies around you is really neglected in school."

"It also usually creates some interest for the students because it is slightly more in reality."

A dividing line can thus be discerned in terms of whether teaching for authentic learning should involve private companies or not.

4.1.4. View on teaching in the subject

In the teachers' descriptions and positions, a clear view of teaching in general and in specific subjects emerged. We chose to interview teachers who teach technology and other STEM subjects; and they mainly talk about such teaching. A theme that was strongly expressed is the strong desire to include all students. By "doing something active," investigating something, looking at something in reality, "going out and looking," teachers succeed in capturing everyone's attention. Which is not considered possible in the classroom with sedentary activities linked to textbooks. Going out and meeting reality provides explanations through experiences with multiple senses. Teachers outlined how they can have difficulty explaining certain things to students who have not experienced what is being discussed. Going out and looking, making a study visit, touching, and investigating, talking to different actors becomes for some students the only way to understand. It helps many students who have a different first language and may have come to Sweden recently. Teachers also described how students with different diagnoses and disabilities also benefit from activities in and collaborations with "reality", and expressed how important it is for them to bring all students with them all the time and believe that it should guide their teaching.

"In order for them to understand, it is important to be able to show as many (ways) as possible, when we talk about a moving block, we have to go out and look at a moving block so that they understand."

"Students think it's fun when there are practical things too, not just sitting in their chair but you get to do something."

"I've got a blind student...very interesting to do experiments so that he can take part in it."

Another subtheme that emerged was that teachers always want to listen to students and start from their questions and interests. The questions students ask became the starting point for what is taken up in teaching and guide how teaching should be designed.

"The important thing is that you arouse their interests and that they find it fun."

"I have a plan, but my planning is shaken up based on the students' questions and interest."

"I try to connect as much as I can with students' reality, our reality, so that it becomes something meaningful."

Another related subtheme that appeared in the teachers' reasoning was that students must "understand life." They described how life exists outside of school and the classroom and that students need to develop knowledge and abilities in "life" to understand it better. Among the studied teachers, there was a clear view that should take place in reality, linked to life's tasks, and that these should be understood. It can be about understanding technical systems, building development, energy supply, ecosystem services, chemical processes, etc. according to teachers, most things can be learned in contexts outside of school.

"They have to understand how things are in society, we can't have garbage mountains, they have to make things better."

The teachers in the study talked about an "unconventional culture", that they are distinct teachers who do not think like others, that they look at their subjects differently than many others do. They highlight their difference from other colleagues or many of the teachers who are newly graduated. Teachers believe that they have developed a different view of their teaching and their subjects over many years. Overall, teachers want to explain their teaching for authentic learning with their different view.

"I think I'm the kind of impulsive person who gets a lot of ideas and then I just do it...often it's fun too and then you get energised."

4.2. Aspects related to "nine guiding design elements"

In the teachers' descriptions of the authentic themes, they work with or have worked with, we could see that they cover many different areas, such as water purification, urban planning, personal care products, technical systems in the city, space-related technology, and so on. The aim highlighted was for students to be in an authentic context that gives them the opportunity to experience how knowledge is used in real life. They should also receive questions and assignments that are real. The themes applied well to Herrington & Oliver (2000), except for no (iii); Provide access to expert performances, that was less apparent in the interviews. The teachers communicated and collaborated with the expert, but students more seldom get to work with people outside of school. The projects set out by teachers may involve field trips in which a person, a role, tells the students about what they do and how they work. The students do more seldom directly collaborate and work in this context. However, students were given the opportunity to collaborate with each other and thus construct knowledge together. They receive guidance from the teacher and are given the opportunity to reflect. In some projects, students were also allowed to present their results to an authentic user.

5. DISCUSSION

This study focuses on how teachers who consider themselves to work authentically describe their teaching, and we have interpreted what characterizes the teachers, their teaching, and what seems to enable teaching for authentic learning.

The themes that emerged: Dare to let go, Strong leadership, Need for contacts and View on teaching in the subject, include teachers' views of themselves and their teaching, which seem to revolve around personality, beliefs, commitment, and strengths of the individual teacher, and thus different strategies that are made possible. We observed how all teachers consider the authentic project and approach to be central in teaching, with the curriculum being somewhat squeezed in. Although they do follow the curriculum, the authentic approach takes precedence. At the same time, the teachers described often feeling alone in their role and their approach to teaching. Colleagues may express scepticism, concerns about losing control, or believe that the approach is demanding. The teachers also expressed how newly graduated teachers may find it challenging to embrace authentic teaching. Possibly, teacher education programs are influenced by a logic that does not directly encourage prospective teachers to develop the perspectives and attitudes that characterise authentic teaching.

In essence, all nine guiding elements highlighted by Herrington and Oliver (2000; 2010) as characteristics of authentic learning instruction emerged in the teachers' descriptions of teaching examples. They allowed students to experience authentic learning to a great extent, encountering real problems and challenges, collaborating with each other, visiting real environments, and carrying out real tasks. Their teachers acted as guides who also allow students to seek and find knowledge from other sources, etc.

What did not seem to be fully enabled was students' opportunity to truly collaborate with actors outside of school. The teachers took the contacts, and the students did encounter individuals with specific roles outside of school, primarily during field trips or for occasional meetings (such as a presentation or other specific tasks). However, there were no concrete collaborations or consultations, discussions, etc., with actors outside of school for the students.

Although students did encounter real problems and tasks, which according to the teachers enable authentic learning (as described by Herrington & Oliver, 2000; Rule, 2006), the teachers attempt to guide them in addressing the complexity of the problems (an important aspect of authentic teaching according to Peters & Tarpey, 2019). Many teaching examples featured problems related to major societal challenges of our time (emphasized by Cross & Congreve, 2020), but when students did not interact with different actors and interest groups in their concrete work, when they were not challenged in discussions by actors outside of school, they may have difficulty fully grasping the complexity and challenges of the tasks they are working on (the importance of discussing and being challenged regarding complex problems is emphasized by Herrington & Herrington, 2006; Pitchford et al., 2021). The tasks, activities, and examples risk remaining school assignments with an authentic touch rather than authentic work. However, it is likely very difficult for schools and teachers to establish concrete and real collaborations with actors outside of school. Both teachers and actors probably do not have the time. For many actors, it is likely difficult to find the time and value being a collaboration part and actively participating in students' work.

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