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Students' Explanation: Wider Variety of Teaching Methods Increases Motivation and Give Higher Results in Biology

Abstract

According to a previous study, results in one topic within an Upper Secondary School Biology course were increased due to student centered, formative working methods. The current study investigates student's perspective on the reasons for the observed increase in performance through focus group discussions. According to the findings, there was not a single factor explaining the increased result, but students felt more motivated during the topic, mainly due to the increased variation in working methods, ways to learn, and examination format. By phrasing goals in their own words and planning activities in order to achieve goals, transparency increased, and the students felt met at their level of prior knowledge. By allowing students to suggest and choose their own working methods that met individual learning styles, students were more interested in the material and motivated to learn. Having an oral examination in a science subject was new to the students. The oral examination added variation to the assessment format and the way students had to prepare for the assessment, which, in turn, influenced the increase in the assessment results. Formative methods may be more applicable in certain topics, and practical implications are discussed.

Introduction

Concepts of formative assessment or assessment for learning has been proposed to enhance student learning (Hattie, 2009; Wiliam, 2010). Formative assessment must not be seen as one specific action but consists of several different parts, all with the aim of finding student misconceptions, providing clarification and ensuring student understanding (Bloom, 1984; Sadler, 1989). Below are three, commonly used (own observation), essential parts of formative teaching methods presented.

1) An important part of enhancing student learning is understanding of goals and criteria (Jönsson, 2010; Rust, Price, & O'Donovan, 2003; Stiggins, 2005). As pointed out by Stiggins (2005) and Wiliam (2011), assessment for learning starts by providing students with a clear, student-friendly vision of the achievement target. The vision should be further enhanced by discussions and provide exemplars of strong and weak work for the students to reflect upon (Stiggins, 2005). General understanding by students of such criteria is difficult as documented by Orsmond, Merry and Reiling (1996). In the study by Orsmond et al. (1996), university students were asked to assess however the criteria "a distinct and well-founded conclusion" was fulfilled. The result showed that students were unable to recognize such a criterion, even when presented to it. This points out the need for finding ways to make students understand the assessment criteria and, hence, achieve them before, or during the examination.

2) Another fundamental part of the concept of formative assessment is the opportunity for students to receive feedback on their achievements during learning to improve their performance (Hattie, 2009, Wiliam, 2011). Several studies show that feedback is essential and leads to better performance, (Hattie & Timperley, 2007; Havnes, Smith, Dysthe, & Ludvigsen, 2012; Merry & Orsmond, 2008); however, teachers tended to rate the quality of feedback significantly higher than students. For students, to be able to use feedback for improvement, it is important that feedback is provided when the student is receptive, and it should be specific and supportive (Hattie & Timperley, 2007; Havnes et al., 2012; Shute, 2008). Carrillo-de-la-Peña et al. (2009) showed that participation in a test group receiving feedback was a better predictor of the outcome than test scores, which supports the importance of feedback. Feedback seems to generate more significant involvement in the learning process, finally leading to higher academic performance.

3) Peer assessment or peer coaching is an effective strategy in formative teaching. Asghar (2010) discusses the potential of peer coaching in increasing motivation for students in higher education since students share an interdependent goal and appreciate immediate feedback. Scientific discussions among peers have been shown to increase students' interest in science which, in combination with ordinary teaching, may have a positive effect on learning, as discussed in Kang and Keinonen (2017). Peer assessment is also mentioned as an important factor for student learning in, e.g., Hattie (2009) and Petty (2009).

For a teacher, there are numerous ways of ensuring that students have good conditions for understanding and learning but different circumstances or constraints may affect teachers' practices. Need for prioritizing among possible formative methods arises, and teachers then prefer to use methods that are proven to be effective and appreciated by students. Formative methods seem to enhance students' motivation to learn. Motivation is defined as "an internal state that arouses, directs, and sustains students' behavior", and can be divided into many different constructs (Koballa Jr. & Glynn, 2007). Formative methods are classroom practices that affect several constructs, e.g. interest and curiosity; intrinsic motivation; goal-determination; and expectations, in ways that increases students' motivation. To get a better understanding of motivation it is important to identify processes that lead to enhanced motivation and learning (Koballa Jr. & Glynn, 2007).

There is substantial evidence that formative methods enhance learning and motivation to learn (Hattie 2009). Carrillo-de-la-Peña et al. (2009) showed that pre-graduate students who took a non-compulsory, formative mid-term test got better grades and had higher success in final summative assessment compared to students who did not participate.

A Swedish example showing the correlation between formative methods and student achievement is a study by Granbom (2015) showing that students, taught with a formative framing, achieved better results measured as grades on a specific topic in a biology course on the Science program in a Swedish Upper Secondary school.

The current study is based on the intervention that was described and quantitatively analyzed by Granbom (2015). Granbom (2015) shows that students' results from one topic were significantly higher compared to results from other topics within the same biology course. The study was based on six classes consisting of 20 (±1), second-year students, 17 years of age, studying biology. All topics, within the 100-hour course Biology A (Skolverket 2000) were taught by the same teacher during one school year. In this case, the course was divided into five different topics; Cell Biology, Genetics, Gene Technology, Evolution, and Ecology; and the intervention took place during the Gene Technology topic where students got to take greater responsibilities regarding planning, choice of methods, the design of examination criteria, and choice of examination form. Regarding examination form, all classes chose oral examination which was carried out in small groups. The procedure is described in detail in Granbom (2015). Other topics were taught and planned by the teacher and assessed by written exams in combination with practical work. Assessment criteria (Skolverket, 2000) were the same for all topics. Granbom (2015) concluded that the formative design resulted in better student performance and that the most important factor influencing student success seemed to be the students' involvement in the planning and construction of the learning goals.

To better understand why the formative design resulted in increased performance, this study aims to qualitatively outline students' views of how different aspects of formative teaching methods can influence learning and result in higher grades.

Methods

In this study, students' explanations as to why formative methods resulted in increased performance were explored. Interviews were performed as focus group interviews in order to generate data from group interaction and to facilitate discussion and reflection.

Procedure and data

Focus group interviews were conducted in the evenings of May 15th, and May 27th, 2013 at Katedralskolan and the interviews lasted 77 and 78 minutes, respectively. Both focus group interviews were moderated by the first author. As suggested by, e.g., Krueger and Casey (2014), one additional person acted as co-moderator (active observer) to make sure that all opinions were discussed and to bring some clarification to the discussion when needed. Before starting the interviews, participants signed a formal consent.

A semi-structured interview guide was developed according to the aim of the study, and it focused on gathering data to explore why students got higher grades on this specific topic. To spark the conversation, participants were asked to tell what they remembered from the topic. Additionally, students were encouraged to evaluate strengths and weaknesses of the different methods and activities.

Focus group interviews were recorded using both a video recorder and a digital voice recorder (iRecorder). The audio files were used to transcribe the interviews verbatim. On some occasions, the video recordings were used to clarify who was speaking.

Study participants

When including participants for focus group interviews, the goal was to select students who left school recently enough to remember the content but still with some perspective, from university studies or work experience. These criteria were fulfilled in two classes which both graduated one year before the interview, i.e., 2012. Patton (2002) suggests that focus groups tend to work best when participants are strangers to each other. Although, since formative methods result in unique planning, one focus group per class was created. They then shared the same experiences, and the need to position oneself

in relation to others was reduced. Participants for focus group interviews were invited in alphabetical order from the class directory. One focus group was formed for each class resulting in a total of two groups of eight participants (n=16).

Analyses

Data were analyzed according to qualitative content analysis suggested in, Patton (2002) and performed inductively, without pre-decided themes. Focus group interviews were coded. Quotes that expressed different opinions or preferences were also used to point out differences and show variation in data. After coding both interviews, codes that were coherent and consistent were grouped into preliminary categories. To ensure that preliminary categories showed internal homogeneity and external heterogeneity, descriptions for all preliminary categories were made (Patton, 2002). Some preliminary categories were then merged, and the result consisted of 4 final categories, "motivation", "planning and deciding", "different ways to learn", and "examination".

Findings

The students' explanation for the improved performance was the considerable variation in methods and activities that made them feel motivated. Variation was discussed and exemplified within three categories: planning and deciding on working methods, different ways to learn, and examination format. One student said "*…and then there was huge variation. It wasn't like there was one way of learning, and that was it*." meaning that they got information in several different ways and from different perspectives which positively affected learning.

Motivation

Students discussed how the Gene technology topic was different from other topics in the course and different from other subjects. The key message was that they felt interested and motivated throughout the topic. Many students mentioned the classes' choice of different activities as something that made the content more relevant to them. The result was that they felt more motivated to study and learn during this topic compared to topics planned and executed by the teacher. Hence, motivation is the link between the three other categories.

The students were interested in Gene Technology and considered it to be a 'hot topic' since they heard a lot about it in the news and through other media. "*It is more relevant for us. Much more relevant. I mean this with GMO [Genetically Modified Organisms], it is stuff that is discussed in the news, like, every other day, but it has been a long time since I saw someone mention, like, cell division*." Again, there were individual differences, and everybody did not agree that Gene Technology was more interesting than other topics during the course. Some students presented Genetics and Evolution as just as interesting and up-to-date topics. The discussion was tightly linked to the discussion on variation, and one of the students summarized the discussion like this: "*It is easier to get a high grade if you think it is fun and motivating*". All group members agreed with this.

Planning and deciding

The participants expressed that they liked being expected to take part in planning and execution of the topic such as phrasing goals, planning own self-studies, providing and receiving peer feedback, and phrasing assessment criteria for the oral examination. The high level of participation was very different from students' earlier experiences within biology or in other subjects. A positive aspect of including students in the planning was that students felt included in the teaching situation compared to traditional teaching. One student said "*…you meet the students at their level… we have created the goals, and then it is easier to achieve them*". Discussing assessment criteria for one topic was highly appreciated by the students, whereas discussing assessment criteria in the beginning of the entire course was not. Students said that they had insufficient knowledge of the course content.

To phrase assessment criteria in class on the whiteboard was one activity that made the topic different from other topics they studied. One student said "*It was different. That is not a thing that you do in every subject.*" Most participants agreed. Another student said "*well… if we, personally, phrased the assessment criteria, then we must have been thinking a bit – yes, about what we wanted to learn, as you said. We had been discussing what we wanted… Then it gets much more fun, I mean then it becomes easier as well, compared to receiving already determined criteria of what we are supposed to learn*". The same student also expressed skepticism to the low level of student participation in Upper Secondary School and would have liked more engaging activities to make students take greater responsibility for their learning. However, not all students reacted positively to phrasing goals and assessment criteria. One student objected to the benefit "*…because what you get on the whiteboard, it is any way like this, I mean, that it is the students' attempt to resemble what the teacher normally writes, which technically implies that it is no more than an interactive exercise, which you, as soon as you [the student] leave the classroom, have forgotten.*"

Other students put forward that a vital part of phrasing assessment criteria was not the discussion about the criteria *per se*, but rather the fact that it was a discussion about the content of the topic. According to the discussions, course criteria were typically shown to students at the beginning of the course, without any more in-depth discussions. By the use of more student-centered methods, the study participants felt that they got an overview of the complete topic in comparison to when the teacher informs about the outline. This method gave students an opportunity to direct focus to areas they were interested in, as said by one student, "*About phrasing the goals and all that, maybe, isn't so, isn't that important compared to that we were allowed to choose [what to focus on]. That's what I found interesting… because if the group finds something interesting, then they want to learn it, more than just learning crap only because you need to study it.*" Other group participants agreed with this sentiment. And in both focus groups, the opportunity to choose was mentioned as something different in relation to students' experiences and thereby adding variation.

Different Ways to Learn

The participants expressed that they appreciated that they got the opportunity to suggest and then choose working methods, which also resulted in a wide variety of learning activities. When the focus groups were asked to recall what they actually did during the topic, one student remembered: "*We did many different things, it wasn't just you [the teacher] standing and talking […] but you showed more of different aspects.*". Working methods used were: field trips, lectures from experts in the field, videos, self-studies, traditional lessons, books and magazines, and laboratory work. All students agreed that they had found some of the activities extra motivating and fun and that they looked forward to those activities. One student brought up that students have different learning styles and benefit from different working methods: "*People learn in different ways; so maybe some learned a lot when you were talking [the teacher], some when the invited guests talked and some learned the most when they studied by themselves.*"

One activity several participants appreciated was the lectures from invited experts in the field. While they appreciated listening to someone with current and hands-on experience, more trivial things also increased their appreciation of these lectures. The fact that it was a person from outside the school made the visit exciting and motivating. One student remarked: "*well, it is always interesting when someone from outside, from reality, visits*" and another student said "*It goes – wow – this is a guy researching this field! And even though he doesn't say anything difficult at all, it is exciting to listen to someone unfamiliar.*" Several students from both focus groups liked that the invited experts helped them to apply and see the relevance of their knowledge which is exemplified by this quotation "*I just think that it is nice to connect to research going on right now, and knowing that it is currently an active debate, very up-to-date.*" This method of connecting theory and application added variation and seemed to be an important aspect of increased motivation.

During planning, all classes suggested and chose to devote time for self-studies, i.e., time in school, managed by themselves. Retrospectively, both focus groups were skeptical about devoting lesson time to self-studies. "*[Self-study] …doesn't work. However, if, for example, a guest lecturer will come in two weeks and talk about this and that, and now you are given this amount of time to prepare for the occasion, then it is something good, positive*."

Since many of the students had positive experiences from self-studies at the university but not during Upper Secondary School, a discussion about the reasons arose. Several participants testified about their bad discipline during Upper Secondary School. They concluded that self-studies could add variation to teaching and be a very efficient way of learning, but not for everybody at that age. One student said "*…I did not look up a single book except the subject textbook provided by the teacher, ever, during Upper Secondary School, and that is a shame since it would have been really beneficial for me to do so*."

Examination

To be able to suggest and decide the examination format was unusual and difficult for the students. After listing different formats, all classes decided to choose oral examinations; however, for practical reasons, it could not be performed individually but in small groups instead. The argument for choosing oral examination was that "*all other examinations are written, so we should take the chance to do something different*". Students expressed that oral examination was a new situation in a science subject where all examinations were written. Both focus groups pointed out that it was good to have variation in examination forms since different examination forms favored different students. Besides, they all agreed that it was something new and exciting to be assessed with peers in a group. The presence of peers made the students feel strongly motivated to be well prepared for the examination: "*I study more for an oral exam. Because I think more about how to express myself, not to sound stupid."* The difference in preparation for an oral examination compared to a written examination may have had a positive effect on the result. Most students felt better prepared for the oral examination, but some students stressed that since they were not comfortable speaking in a group, they were convinced that they performed worse on an oral examination compared to a written test.

The groups also discussed the validity of oral tests. Some students not only believed that they earned higher grades on an oral examination compared to a written exam, but also that the grade better reflected their knowledge about the topic. Other students suggested that they would provide more accurate answers if they were given time to think and express themselves in a written exam format. According to the majority in the focus groups, an oral examination was considered more valid than a written test since there were opportunities to correct oneself during the test. If, e.g., a specific term was forgotten you may get help with this term and then continue to show that you could draw complex conclusions or make advanced analyses. In one of the focus groups, there was a discussion about the opportunity to learn during an oral exam in comparison to a written exam. "*So, you get to hear others point of view and so forth… As I recall it, I found it very interesting when we discussed it […] at the same time I think that it… you learned during the examination as well, in my opinion*." Another student said "*But within this topic, I thought that it was good with an oral examination. I mean, mainly because you learned from both what you studied yourself and from what others said*." Oral examinations were, by some, considered better in topics where there are no definite answers, illustrated by the following citation: "*Since there is room for many personal opinions it is easier to express all of them, for some, orally than in writing*." Some students suggested that an oral examination should be combined with a written assignment to test basic understanding so that the oral examination could be focused on higher order thinking.

Discussion

According to the findings of this study, the most important factor affecting student performance, as pointed out by the students, was increased motivation. The students felt motivated by the considerable variation in teaching methods, mentioned explicitly in three categories: participation, working methods, and examination. These factors will be discussed individually, but of course, they enhance each other to create an environment that is beneficial for learning.

Methodological considerations

As stated in the methods, focus groups seemed to be the best way to understand students' perception of their experiences. Groups were created within classes to facilitate discussion since all group members had the same experiences but contributed with their individual reflection (Krueger, 2006). There were some minor differences between years; so for future studies, it would be interesting to include focus groups from different cohorts to minimize the effect of the teacher or the specific activities. To include more teachers would reduce the effect of the teacher further and is also suggested for future studies.

Regarding the members of the groups, there was a concern that participants generally felt more positive about school or the teacher, and that perhaps students with negative memories declined to participate. However, groups were assembled by calling students in alphabetic order until the groups consisted of eight people to minimize the risk of biased selection of participants and only four students declined to participate. Finally, there may be an effect of the teacher being the moderator, but by including an active co-moderator who tried to get all perspectives, effects on the findings were minimized.

Motivation through variation

During focus group interviews, students repeatedly discussed different activities and how motivated they felt by the diversity of activities. According to experiences from the focus groups, student influence on teaching seemed low in general; and a conclusion from this study is that students would like more influence in the designing of learning activities.

Additionally, when students were involved in the planning of activities, they knew what to expect and were sometimes even looking forward to specific activities. Zusho and Edwards (2011) have reviewed studies on motivation for college students. These studies provide evidence suggesting that students who set appropriate goals and plan for learning achieve higher academic results. However, more research is needed to determine whether variation in methods *per se* increases academic result, or if student participation in planning is important. It would also be interesting to study if increased student planning would enhance results if it were demanded for all topics in all subjects. Maybe student involvement has the best effect on motivation and results when student participation adds variation to regular routines, but this has to be studied further.

As mentioned by the students, topics related to gene technology are frequently discussed in media, which motivated some of the students. During the discussion about whether media coverage may have influenced the higher results, several students were skeptical since they found several other topics within the same course to be just as relevant. However, the focus group discussions point out the fact that by connecting a topic to students' everyday life, most students get interested, feel intrinsically motivated, and want to learn more. The connection between personal interest and perceived learning seems to be strong as shown by Ottander and Ekborg (2012) and Sadler (2009). Studies (reviewed in Sadler, 2009) show that working with topics connecting everyday life to schoolwork, e.g., socioscientific issues, increases students' motivation and participation; however, there was no evidence that grades were positively affected in either of the studies (Ottander & Ekborg, 2012; Sadler, 2009).

Planning and deciding

According to this study and one of the authors' observations, it is not common practice that students discuss goals and write them in their own words. Granbom (2015) proposes the specific activity of phrasing goals to be the most important factor for explaining increased results, but that conclusion is not supported by findings of this study. Students did not recognize one specific activity to be more critical than others but rather the wide variety of activities. On the other hand, phrasing goals is not unimportant. One of the benefits of phrasing goals, as expressed by the students, is that they feel met at their level and guided towards mastery of the topic. Discussions about goals and content force students to think about learning and quality. When students see "the whole picture", they feel like they have more control over the situation, and therefore are able to relax and enjoy the activities during the topic. In the focus groups, all students agreed that there was a benefit to discussing assessment criteria in advance. The importance of discussing assessment is emphasized by Rust et al. (2003) who has shown that it is difficult to explain explicit assessment criteria and grade descriptors to complex tasks, which leads to the conclusion that students who participate in discussions will achieve this tacit knowledge. Students not engaging in discussions will not get the benefits. This is supported by, e.g., Marzano, Gaddy, and Dean (2000) and Rust et al. (2003) who show the importance of setting goals that point out the direction for achievement. By combining discussions about goal with the planning of learning and examination, overall transparency for students will increase. With closer alignment of instruction, expectations, goals, and assessment, students are given better chances to focus on the quality of their performance and the goals they want to achieve (Jönsson, Lundahl, & Holmgren, 2015; Nolen, 2003). There is also a benefit of discussing goals in the classroom since it makes it more of a contract between students and teacher, which also may contribute to the increased performance by students in this study (Crichton & McDaid, 2016; Marzano et al., 2000; Meece, Anderman, & Anderman, 2006).

When planning the topic, the students showed a lot of creativity in finding different activities. Planning learning activities was new to many of the students and thereby added variation to the topic. At the same time, the resulting learning activities showed greater variation than the previous teaching in biology and evoked more considerable interest among students. All activities gave rise to discussions, fact-checking, and analyses from which students were supposed to draw personal conclusions. Conclusions were not only drawn from a biological point of view but from the student's available knowledge from different fields. Discussions, analyses, and conclusions demand critical thinking, which has been shown to play an important role in learning (Kang & Keinonen, 2017; Pithers & Soden, 2000). The critical thinking needed to connect theory with student everyday life may play an essential role in increasing student motivation and learning (Abrami et al., 2008; Kang & Keinonen, 2017; Ottander & Ekborg, 2012). In Abrami *et al.* (2008) and Hattie (2009) effect sizes for metacognition were high, which supports the conclusion that variation may be a key factor in the increased student performance.

Different ways to learn

A review by Bennett (2007) showed that students who work with societal focus on science questions were generally more interested and had a more positive attitude to science, which plays an important role in student learning. Gene technology must be seen as a complex, socioscientific issue (SSI), and it has been proposed that working with SSI may provide students with different perspectives, an ongoing inquiry, and critical examination of arguments (Sadler, Barab, & Scott, 2007), factors that may enhance motivation (Pintrich, 2003). Findings from this study show that students felt motivated by the great variation, and variation was created e.g. when students chose different working methods based on their interest and experiences. The result was a plan for the coming weeks that consisted of a wide variety of activities. Focus groups delved deeper into the discussion about two of the working methods, the invitation of experts and self-studies. One activity that all students remembered from the topic was the invitation of experts who gave lectures on his or her area of expertise and the way

gene technology was used in that specific field. Students could relate to recent newspaper articles and TV-news which made the lectures connect to students' everyday life. The lecture by the expert also helped students place their knowledge into context and see the connection between theory and knowledge. During the lecture, students were also able to ask questions and discuss issues that they found intriguing. The invited experts expressed both positive and negative aspects of the use of gene technology which fit very well into the students' goal of taking a stand in the gene technology issue. The students were well prepared and excited to meet the expert, and, according to Sadler (2009) the change of settings for learning to be outside the normal classroom routine may have a positive effect on students' interest and motivation. When preparing to meet the invited expert, students revised and discussed the topic that was going to be presented. This type of guided inquiry has been shown to have a positive effect on learning (Kang & Keinonen, 2017; Sadeh & Zion, 2011); and according to the findings in this study, it may have had a significant impact on student performance.

During the planning of the working procedure, students decided to devote time for self-studies. Self-studies can be described as time where students seek answers to questions posed by themselves. Generally, this working method rarely occurs in Upper Secondary School or more specifically in science subjects. During focus group interviews, it became evident that, when looking back, this was not well invested time or effort. Despite students' desire for self-study time during the topic, they later considered themselves too immature to handle this responsibility. Most members of the interview groups had been exposed to self-studies at the university and considered the study method highly effective; however, they all agreed that they were not using the time well during Upper Secondary School. Focus group members agreed that self-studies could be a very efficient way of learning given more teacher guidance, i.e., through defined questions to answer. A more guided approach is supported by Kirschner, Sweller, and Clark (2006) who suggest that self-regulated studies can only be done in a useful way when a student has considerable knowledge of the field. In new contexts, the cognitive load gets excessive and prevents efficient learning (Kirschner et al., 2006). Also, Kang and Keinonen (2017) suggest guided inquiry as a method for increasing results and interest in science. Data from PISA 2006 shows that, in general, open inquiry has a positive effect on interest in science but a negative effect on assessment results (Jiang & McComas, 2015). For Finnish students, however, open inquiry has an adverse effect on interest in science, according to data from PISA 2006 (Kang & Keinonen, 2017). According to Kang and Keinonen (2017) and Lavonen and Laaksonen (2009), Finnish students rarely face open inquiry, which may be an explanation to the observed difference between the Finnish and the global result when comparing data from PISA 2006.

Examination

Oral examination was subjected to significant discussions in the focus group interviews, both as part of the variation and as a separate factor affecting the increased result of the topic. First, the findings show that it is rare with oral examinations in Upper Secondary School in general and in science subjects specifically, possibly due to time constraints and the nature of science (own observations). The proportion of different examination forms has not been widely studied in Upper Secondary School and most information today comes from studies on higher education. A study of examination form on undergraduate studies in the UK shows that only about 1% of the examinations were non-written (Hounsell et al., 2007). Specific course criteria in different subjects may be more or less suitable for alternative forms of examination. When studying science subjects in Upper Secondary Schools in Sweden, i.e., biology, physics, and chemistry, students are assessed on ethical discussions and connection between science and society according to course criteria. From those criteria, oral examinations are highly recommended. Interviews showed that students appreciated having an oral examination since they thought that it was a good way of assessing knowledge in relation to the assessment criteria. They were also encouraged to prepare for the examination differently compared to what they were used to, which was appreciated by the majority.

When discussing the difference between oral and written examinations, participants in the focus group interviews reacted positively to oral exams since they thought that they not only earned higher grades on oral exams but that, more importantly, the oral examinations provided more accurate assessments of their knowledge compared to written examinations. Huxham, Campbell, and Westwood (2012) describe how undergraduate students perform better in oral examinations compared to written in a study where students were tested in both examination forms. The result also showed that students were more nervous for the oral examination since they had low experience of the examination form. The nervousness may have prompted them to prepare more thoroughly for an oral examination than they would have prepared for an examination form they were used to (Huxham et al., 2012). According to Joughin (2007), students believe that oral examination demands deeper understanding and lead to better learning, which may affect the result in Granbom (2015). There were, however, also objections to oral examinations. An objection several participants agreed upon was that it is difficult to test basic knowledge. Therefore, the groups suggested that a written test where basic knowledge and vocabulary was tested should proceed an oral examination where higher order thinking should be assessed. According to this study, oral exams should be used more often in biology. However, more research on oral exams in secondary education is needed to increase knowledge about validity and reliability.

Practical implications

By letting students write goals and criteria in their own words and then discuss the meaning and evidence for achieving them, more transparency and understanding may be reached. Writing goals and criteria provide an overview of the topic making it possible for students to influence methods and content. Students then have a chance to suggest working methods, which favor many different ways to learn and may lead to increased motivation. It is worth noting, that students did not think that unguided self-study was well invested time for Upper Secondary School students. However, in contrast, university students regarded self-study as highly efficient.

Further, findings in this study indicate that activities relating theory to student experiences or application of knowledge increases motivation and results. Activities may include reading news, watching documentaries, and discussions on the future of gene technology, all activities that connect the topic to students' everyday life. Invited guest speakers were highly appreciated and increased student motivation according to the focus group discussions.

By varying examination format, students are encouraged to prepare in different ways compared to what they are used to. In this study, oral examination was used and considered a valid method by the students, and well suited to assess the specific topic. According to the findings in this study, oral examinations seem to be underutilized in science subjects but are considered more valid and reliable compared to written examinations.

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