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Abstract

This study investigates upper secondary students’ situational interest in a collaborative citizen science program that involves genetic monitoring of freshwater fauna by analysing environmental DNA (eDNA) extracted from local pond water. The program was attended by a sample that comprised 1,879 students (\(M_{age} = 18.15, SD = 1.94\)) from 105 classes. The results indicate that students were excited by the highly sophisticated laboratory procedure. However, the most important finding was that students’ own contributions in terms of collecting and analysing samples had only a small predictive effect on their interest. I hypothesize that this is because students participating in citizen science programs as part of their science classes are governed by curricular requirements, and thus by extrinsic goals (i.e. “mandatory volunteerism”). Thus, they may not be convinced that they are actually contributing to research, but instead may feel that they are participating in a curricular learning design. Furthermore, such educational programs generally offer a low level of ownership, as the student has little or no involvement in the personalizing tasks based on individual interests. This raises the question of whether citizen science educational programs actually support the internalization of values and thus interest.

Keywords: interest, citizen science, upper secondary education
Predictors of students’ interest in a citizen science program

Many students perceive the sciences as irrelevant because the subjects do not relate to their daily lives (Aikenhead, 1996; Archer et al., 2010; Osborne, 2003). According to Osborne, this absence of perceived relevance limit student interest development in the field. The literature suggests that making the study of science relevant to the students should be a key goal of science education (National Research Council, 2012; Stuckey, Hofstein, Mamlok-Naaman, & Eilks, 2013). One promising way to achieve this is citizen science, as it enables students to apply science, for example, to local environmental issues, in collaboration with scientists. “Citizen science” refers to projects in which interested members of the public, often without specialized scientific training, participate in the scientific process to address real-world problems (Phillips, Ballard, Lewenstein, & Bonney, 2019). Unlike what often happens in school settings, students in citizen science programs often have the opportunity to make meaningful contributions to science by engaging in activities that resemble research practices. The scientific data that the students collect for these projects is directly related to their local contexts (Wals, Brody, Dillon, & Stevenson, 2014). There is now evidence that citizen science activities can lead to the development of motivation and skills in interested members of the public (Brossard, Lewenstein, & Bonney, 2005; Jones, Childers, Andre, Corin, & Hite, 2018; Nov, Arazy, & Anderson, 2014; Phillips et al., 2019; Price & Lee, 2013; Rotman et al., 2012). There has been far less research regarding secondary school students’ interest in school-related citizen science programs. However, there are studies that suggest that such programs improve student motivation to be involved in environmental matters (Hiller & Kitsantas, 2014; Kelemen-Finan, Scheuch, & Winter, 2018; Silva et al., 2016). When students participate in such programs, authenticity and relevance is achieved by drawing connections between curricular content, real-world problems,
and students’ everyday lives. Thus, citizen science programs may offer an instructional approach that may heighten student interest and promote STEM-related careers.

This study investigates upper secondary students’ interest in a citizen science program. The students detected the presence of freshwater fauna – amphibians, fish, crustaceans, and insects – by analysing environmental DNA (eDNA) extracted from the students’ local pond water. Genetically monitoring freshwater species through water samples is a ground-breaking scientific method (Kelly et al., 2014; Thomsen et al., 2012). This study investigates the significance of the citizen science element: how students’ own contributions to research predict their interest in it. However, before presenting the actual study, it is essential to first conceptualize “interest”.

**Theoretical framework**

“Interest” is a content-specific motivational concept, that is, it identifies a specific and distinctive relationship between a person and a particular object of interest (be it a topic, task, or activity). Interest in a subject area predicts effort and persistence (Fryer & Ainley, 2019; Jansen, Lüdtke, & Schroeders, 2016; Nieswandt & Horowitz, 2015; Tapola, Veermans, & Niemivirta, 2013). Moreover, interest is a significant factor in making sustainable education and career choices (Bøe, 2012; J. Eccles, 2009; Harackiewicz, Barron, Tauer, & Elliot, 2002; Lykkegaard & Ulriksen, 2016).

A distinction is usually made between two types of interest: individual and situational interest. Whereas individual interest is defined as a relatively stable set of valence beliefs, situational interest is conceptualized as a psychological state of being involved with content (Krapp, 2002). More specifically, situational interest is generated by certain conditions in the
environment, such as a specific topic-related activity (e.g., running a gel electrophoresis), which may or may not develop further (Knogler, Harackiewicz, Gegenfurtner, & Lewalter, 2015).

An interest in something is composed of feeling-related and value-related valences (Krapp, 2002; Schierfele, 2009). The term feeling-related valences is used when a topic or object is associated with feelings of happiness and enjoyment, or follow activity involving the topic or object of interest. The value-related valences refers to attribution personal significance to a topic of interest. In order to maintain students’ interest it is necessary emphasize the relevance, or meaningfulness, of subject content (Dewey, 1913; Krapp, 2002). Meaningfulness refers to students’ perception of subject content as being relevant to their daily lives. For example, if students experience their involvement in a learning activity as meaningful, and they enjoy the activity, they are likely to develop a more sustained interest in the domain.

Perceiving an activity as relevant to real life is predictive of subsequent interest (Harackiewicz & Knogler, 2017; Hulleman & Harackiewicz, 2009). However, the meaning of “relevant” as a psychological construct is usually inadequately conceptualized in the literature. A review by Stuckey, Hofstein, Mamlok-Naaman, and Eilks (2013) reveals that the term “relevance” has widely varying meanings in the science education literature. Stuckey and his colleagues group the literature into five main categories, but point out that the distinctions among them are not always clear. Next, I discuss and further develop these categories, and also draw on literature not presented in this review.

The first category of literature uses “relevance” as a synonym for student interest (e.g., by Schreiner & Sjøberg, 2004). This conceptualization builds on a sociological approach to interest, not a psychological one, which is the focus of this article. Therefore, this category will not be elaborated further.
The second category of literature applies relevance as students’ perception of subject content as being relevant to their daily lives. Meaningfulness refers to the way knowledge gained from experiences is conceptually anchored to new information provided by a learning situation. At some point a student has a “focus” – the present object or aspect on which he or she concentrate, and a “horizon” – social background, personal experiences, physical space – that may be connected to the focus. Thus, meaningfulness is the property that determines the connections and relationships in our complex social world, or “lifeworld” (Schutz & Zaner, 1970). This is exemplified by the German program, Biology in Context, which has a curriculum that is designed to connect the roles of biology and its related applications to the students’ everyday lives (Elster, 2009). The use of contextualized learning material is supposed to stimulate situational interest (Habig et al., 2018; Walkington & Bernacki, 2014). However, studies have shown that what a learner experiences as personally meaningfully is not necessarily shared by others. Pugh’s (2004) description of the contrasting experiences of two students learning Newton’s Laws illustrate this. One student related this subject matter to his experience of events of motion in his everyday life, and found it interesting, whereas the other did not. The other student was motivated by peripheral things, such as humour, the opportunity to interact with others, etc. but never regarded Newton’s laws themselves as relevant. Hartwell and Kaplan (2018) have proposed a model that describes the subjective perception of relevance as the cognitive and affective connection between the academic content and the learner’s identification with content.

In the third category of literature, relevance is used as a synonym for usefulness or utility value. Utility value refers to the perceived instrumentality of subject matter to one’s goals (J. S. Eccles et al., 1983; Gaspard et al., 2015; Hulleman, Kosovich, Barron, & Daniel, 2017). Often,
students participate in classroom activities not because the activities themselves are interesting, but because they are instrumental to some desired outcome that is distinct from the activity itself. Studies have shown that low-achieving students in particular can develop an interest in science through utility-value interventions where students are prompted to make connections between course material and their lives (e.g.: Hulleman & Harackiewicz, 2009). Although experience of utility value is proposed to have impact on interest development, the exact mechanism is not clear. Utility value can be characterized by extrinsic value beliefs and thus extrinsic motivation, whereas the value-related valences of interest are intrinsic and directly related to the object of interest. For example, if a student engages in biology lessons in order to get good grades in biology, then this student holds extrinsic value beliefs which appears as extrinsic motivation (Schiefele, 2009). Thus, one would not speak of the value component of their interest, but of utility value.

In the fourth category of literature, relevance refers to the individual's influence on environmental and societal development, for example by relating to how technology can contribute to sustainable development. Stuckey and colleagues (2013) argue that relevance can be attributed to three dimensions: individual, societal, and vocational. Where the three previous categories of literature are clearly individual by nature, the fourth category also includes social and vocational aspects in terms of behaving as a responsible citizen and contributing to society’s development. This description is consistent with the ideas of citizen science, as it gives the individual the opportunity to participate in society around local environmental issues and thereby develop the necessary competencies to act responsibly in society in the future (Roth & Lee, 2004). Individuals may contribute to citizen science from a aspiration to contribute to science without reward to themselves (Jones et al., 2018). Relevance recognized by the individual may
be self-focused and other-focused. A “self-focused” value is called an “agent value”, and refers to qualities for pursuing individual goals. An “other-focused” value is called a “communal value”, and refers to qualities relevant for being a member of social groups and helping others (Brown, Smith, Thoman, Allen, & Muragishi, 2015; Rosso, Dekas, & Wrzesniewski, 2010). When individuals participate in citizen science for altruistic reasons, the perception of relevance of their contribution can be described as communal value valence.

Finally, in the fifth category of literature, relevance is described multi-dimensionally including selected elements from the four previous categories.

This study aims to investigate maintained situational interest, as conceptualized in the person-object theory of interest (Krapp, 2002; Schiefele, 1999, 2009). This means that value valences are integral parts of the concept of interest, not separate concepts, as utility value is in expectancy-value theory. Thus, a theoretically satisfactory metric for interest would have to use affective (enjoyment) and value-related (relevance) valences of the interest construct as a basis for operationalization. Previous studies (e.g., Schiefele, 1991; Schiefele, Krapp, Wild, & Winteler, 1993) have shown that this metric is unidimensional. Also, since it may be possible to differentiate between various value valences, depending on the basic motives for engagement (e.g., “self-focused” and “other-focused”), this study distinguishes between two forms of relevance, or value valences, corresponding to categories II and IV above, to study students’ interest in citizen science.

Citizen science in upper secondary schools

There are a few studies of students’ interest during participating in citizen science programs, especially at the upper secondary level. Kelemen-Finan, Scheuch, and Winter (2018) investigated students’ interest and motivation in biodiversity projects. Students registered bird,
butterfly, and hedgehog presence, as well as wild bee foraging behaviour. The findings indicated that upper secondary students’ interest and motivation was significantly lower than for younger students. No gender differences were found.

Aivelo and Huovelin (2020) investigated upper secondary students’ interest in an urban rat project. Students collected rat incidence data with track plates, showing paw prints walking on the plate. Interview data suggested that students' situational interest was stimulated by the perception of meaningfulness: that the activities were not “in vain” but perceived as contribution to an actual research project. Gender differences were not investigated.

Silva, Monteiro, Manahl, Lostal, Holocher-Ertl, Andrade, Brasileiro, Mota, Sanz, Carrodeguas, and Brito (2016) investigated upper secondary students’ motivational outcome in a project on cell biology research. The results indicate participation created interest among students, but interest was not conceptualized in this study.

Schneiderhan-Opel and Bogner (2020) investigated upper secondary students’ fascination for biology in a biodiversity citizen science project. Fascination was conceptualized to embody concepts of curiosity, interest, and identification with scientific enquiry. Students collected soil samples at forests near their homes and registered GPS location, composition, and condition of the respective forest. The authors found no change in fascination for biology from pre- to post-test. Gender differences were not investigated.

This study

A review of the literature suggest that citizen science projects might promote upper secondary students’ interest, but it is not clear what aspects of citizen science are important. Besides, there is uncertainty about the extent to which citizen science creates equal interest in both sexes. Empirical evidence suggests that female students are significantly more interested in
biology in general than male students are (Blankenburg, Höffler, & Parchmann, 2016; Jansen, Schroeders, Lüdtke, & Marsh, 2019), but Kelemen-Finan, Scheuch, and Winter (2018) found no differences in their study of citizen science. In addition, studies have shown that individual interest predicts situational interest (e.g., Durik & Harackiewicz, 2007; Holstermann, Ainley, Grube, Roick, & Bögeholz, 2012; Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008), as individual interest promotes a positive and inquisitive orientation to a task. Thus, it is an open question how students’ individual interest and preferences in terms of program of study might influence their situational interests in a citizen science program. Hence, the purpose of this study is to investigate upper secondary students’ interest in a citizen science program involving genetic monitoring of freshwater species through water samples. The four research questions were:

1. To what degree does collecting water samples and detecting eDNA predict students’ situational interest?
2. How does gender predict students’ situational interest?
3. How does program of study predict students’ situational interest?
4. What are the interactions among interest measures?

**Methods**

**Description of the citizen science program**

Biodiversity conservation depend on monitoring species and populations. Biological monitoring has traditionally relied on physically identifying species and counting individuals but identification depends on taxonomic expertise. A new and effective method for monitoring biodiversity is environmental DNA (eDNA) – that is genetic material extracted directly from environmental samples (Kelly et al., 2014; Thomsen & Willerslev, 2015). DNA from higher organisms persists in the environment, as species constantly expel cells into their surroundings.
Environmental DNA extracted from aquatic samples provides a reliable assessment of the biodiversity in and around the water. This has been shown in freshwater ecosystems by eDNA from invasive and scarce species, including crayfish, amphibians, and fishes (Agersnap et al., 2017; Thomsen et al., 2012), and, more recently, in marine ecosystems when monitoring fish species (Knudsen et al., 2019; Thomsen et al., 2016). Environmental DNA monitoring has a strong advantage over conventional techniques because collecting water samples for analysis is usually more straightforward than physically identifying species. This creates a new opportunity for monitoring undertaken by volunteers in citizen science programs, such as the British program for the great crested newt (Biggs et al., 2015), for example.

The citizen science program, DNA & Life, is an educational program developed by the Natural History Museum of Denmark, which targets upper secondary school levels. According to Philips, Ballard, and Lewenstein (2019), DNA & Life is a collaborative project. Students map selected animals by analysing eDNA collected from fresh water. The eDNA samples are analysed by amplification using a polymerase chain reaction (PCR), by means of specific primers for a number of organisms. First, students choose a local pond or lake and collect water samples. The samples are sent to the museum, where they are prepared by museum technicians. Next, the class participates in a full-day program at the DNA Lab, the Natural History Museum’s teaching laboratory. A visit begins with the museum’s instructors’ presentation of biodiversity monitoring techniques. Working in pairs, students then prepare their species-specific PCR mix and place their samples in a real-time PCR machine. While the PCR is running, students classify ten dead and preserved freshwater fish species using a taxonomic key. This hands-on activity exemplifies the traditional method of physically identifying species by visual survey. After finalizing the PCR, students interpret the amplification plots and compare their findings with the National Fish
Atlas Database, hosted by the museum. New findings of fish distributions are registered in the database. Table 1 shows a summary of students’ findings. The museum instructors facilitate a discussion among the students, of the affordances and constraints of the two methods of identifying species for biodiversity monitoring. For example, if students are unable to detect eDNA in their samples, it does not necessarily mean that the species in question does not live at the site (failure to detect DNA is common in studies where the concentration of genetic material is often low). Students bring their results back to school, typically to write a report on the biology experiment.

(Insert Table 1 here)

**Participants and procedure**

The study sample comprised 1,879 upper secondary students who attended the DNA & Life program over a period of 18 months. The sample was drawn from 105 classes from 62 upper secondary schools in Denmark. The age of the participants ranged from 15 to 47 years (\(M_{age} = 18.15, SD = 1.94\)). With regard to gender, 1,173 (62.4%) of the participants were women, and 706 (37.6%) were men. The Danish school system comprises 10 years of compulsory primary and lower secondary education, and an additional three years of optional upper secondary education, which may be taken later in life if it was not attended consecutively to the first 10 years. Students may choose one of three levels of biology at the upper secondary level: C (lowest level, one year), B (two years), and A (three years). Biotechnology is a thematic program of study, equivalent to biology level A, but with another curriculum. The sample comprised 80 students (4.3%) at level C, 362 (19.3%) at level B, 624 (33.2%) at level A, and 813 (43.3%) in Biotechnology.
Triggered situational interest refers to an interest caught in a given situation and should consequently be measured *in situ*. Maintained situational interest is more persistent and is therefore less critical in terms of when it is measured. Thus, in this study, participants’ maintained situational interest was measured in a pen and paper format at the end of the full-day citizen science program, just before leaving the museum. The response rate was above 99.9%.

**Instrument**

The situational interest instrument developed for this study is framed on the scale for measuring maintained situational interest, developed by Linnenbrink-Garcia and her colleagues (2010). Items were adjusted to measure feeling-related and value-related beliefs regarding the specific activities at the DNA Lab. The instrument consisted of four specific components (latent variables) that are thematically connected in pairs (Table 2). The first component measures an interest in detecting fauna by sequencing eDNA. It comprises seven items on the affective valences of interest. The second component measures interest in terms of value valences, that is, the value the students placed on their contribution to citizen science. This scale is aligned with conceptualizing relevance in terms of the desire to make a worthwhile contribution, that is, “communal value”. The third component measures the affective valences of an interest in comparing two methods for identifying species (eDNA and comparative morphology). Based on inter-item correlations, two items were excluded from subsequent analyses, resulting in a two-item scale. The fourth component measures interest as value valences, specified as students’ perception of the meaningfulness of connecting contexts to their lives. This scale reflect the value the students placed on knowledge on different methods for taxonomy. The 19 interest items were scored on a 5-point Likert scale ranging from 1 (*disagree*) to 5 (*agree*).

(Insert Table 2 here)
The instrument includes independent background variables, such as gender, age, and program of study. Students were also asked whether they participated in collecting water samples, and whether they were able to detect eDNA in their own water samples. The independent variables were coded as dummy variables.

**Analytic Approach**

All modelling was conducted with AMOS 26, using the maximum likelihood algorithm. Initially, responses to negatively worded items were reversed. Next, I conducted a missing-data analysis. Missing data comprised less than 0.005% of the interest data, and less than 0.1% of the background data. Missing data was substituted by deterministic hot-deck imputation (Andridge & Little, 2010). I conducted exploratory factor analyses (EFA) using maximum likelihood factoring with oblimin rotation to explore whether a 4-factor solution emerged. The four extracted factors accounted for 64.2% of the variance and were related to one another (Bartlett’s Test of Sphericity $p < .001$, KMO = .92). Next, I tested this four-factor model using confirmatory factor analysis (CFA) to confirm the four latent variables in the survey, to develop an acceptable measurement model. Scale reliability was assessed by Cronbach’s alpha.

In the second phase, I built a structural model on the measurement model to examine directional interrelations among the four latent constructs and observable background variables (Kline, 2016). Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) examined the models’ goodness-of-fit along with the $\chi^2$ statistic. For an acceptable fit of the model to the data, and to satisfy construct validity, cut-off values of 0.95 (CFI), 0.95 (TLI), and 0.06 (RMSEA) were used in the analysis (Hu & Bentler, 1998).
Interpretations of the β-coefficient results were based on Keith’s (2014) recommendations. This study employed three levels of β-weights: betas below 0.05 are considered as “too small to be considered meaningful”; those between 0.05 and 0.10 as “small but meaningful”; those between 0.10 and 0.25 as “moderate” and those above 0.25 as “large”.

**Results**

The CFA model that represents the four latent interest components demonstrated a good fit with the data ($\chi^2 = 270.029, p < .000, df = 126, CFI = .992, TLI = .989, RMSEA = .025$). Ideally, chi-square values should not be significant. However, the statistics are very dependent on sample size, and with large samples, chi-square values are usually significant. Therefore, in this study the significance of the chi-square test may be regarded as of limited importance.

Table 3 shows correlations, reliability, and descriptive statistics for the four interest components. Means on all the interest scales were around four on the five point scales, indicating high levels of student interest.

(Insert Table 3 here)

**SEM: Predictive relationships between variables**

The resulting model (Figure 1) showed a good fit to the data ($\chi^2 = 499.688, p < .000, df = 188, CFI = .983, TLI = .977, RMSEA = .030$).

(Insert Figure 1 around here)

The results show that collecting water samples predicts only a small direct effect on the value the students placed on their contribution to citizen science ($\beta = .051, p < .05$). If students detected eDNA in their water samples this had a moderate effect on the first interest scale, an interest in detecting fauna by sequencing eDNA ($\beta = .100, p < .01$), and a small effect on the
value the students placed on their contribution to citizen science ($\beta = .052$, $p < .01$). However, no direct effect on any of the other interest scales was found.

Gender predicted a small direct effect on the first interest subscale, and indicates that female students were more interested in detecting fauna by sequencing eDNA ($\beta = .099$, $p < .001$) than male students were.

Students’ program of study (biotechnology versus biology) predicted a moderate direct effect on an interest in detecting fauna by sequencing eDNA ($\beta = .166$, $p < .001$), and a small negative effect on the value the students placed on their contribution to citizen science ($\beta = -.060$, $p < .01$). Even though I found a significant effect on valuing knowledge of different methods of taxonomy, the $\beta$-weight is too small to be considered meaningful (cf. Keith, 2014).

An interest in detecting fauna by sequencing eDNA was found to be a strong predictor of subsequent interest, in terms of the value the students placed on their contribution to citizen science ($\beta = .572$, $p < .001$), an interest in comparing two methods for identifying species taxonomy ($\beta = .556$, $p < .001$), and valuing knowledge of different methods of taxonomy ($\beta = .281$, $p < .001$). The value the students placed on their contribution to citizen science had a moderate predictive effect on an interest in comparing two methods for identifying species taxonomy ($\beta = .112$, $p < .001$), and valuing knowledge of different methods of taxonomy ($\beta = .126$, $p < .05$). Finally, an interest in comparing two methods for identifying species taxonomy was strongly predictive of valuing knowledge of different methods of taxonomy ($\beta = .325$, $p < .001$).

The standardized regression coefficients resulted in considerable variance explained within the model, demonstrating interdependence of the interest measures ($R^2$: Value the students placed on their contribution to citizen science = .337, Interest in comparing two methods for
identifying species taxonomy = .398, and Valuing knowledge of different methods of taxonomy = .395). In contrast, the extent of variance explained for Interest in detecting fauna by sequencing eDNA was considerably lower ($R^2 = .048$).

**Discussion**

This study tested a structural model of interest in citizen science, and relevant variables were included in the modelling, to evaluate their direct predicting effect. The following sections address the research questions.

**The small effect of students’ contributions to science**

Perhaps the most significant result of this study is that students’ tasks of collecting and analysing data for the citizen science program had only a small predictive effect on the value the students placed on their contribution to citizen science. It has been shown that if university students participate in collecting and analysing real samples for genetic analysis, they are more motivated than control-group students using a “classical” approach for laboratory practices (Borrell, Muñoz-Colmenero, Dopico, Miralles, & Garcia-Vazquez, 2016). In Phillips and her colleagues’ meta-study (2019), one of the main motives for involvement in citizen science was contribution. Thus, it was expected that collecting water samples from local pond water and detecting eDNA in the samples would predict the value the students placed on their contribution to citizen science, owing to ownership and relevance. However, many citizen-science projects that serve education are intended for formal classroom environments or informal educational environments such as museums. Students participating in citizen science programs as part of their science classes are subject to curricular demands, and by extension, their extrinsic goals (i.e., “mandatory volunteerism”). Besides, such educational programs generally offer a low level of ownership, as the student has little or no involvement in personalizing tasks based on
individual interests (Walkington & Bernacki, 2014). This raises the question of whether mandatory volunteerism effectively leads to an internalization of values, and thus to interest (cf. Deci, 1992). However, it should be noted that extrinsic motivation will be experienced as autonomous if students sense ownership of their activity, and completely endorse the value of their activity (Vansteenkiste, Niemiec Christopher, & Soenens, 2010). Thus, students’ motivation for involvement depends on both the externality of curricular demands and the internality of individuals’ basic goals and interests. If students’ perception of relevance and interest are lacking, other factors may be necessary to motivate them, for example, feedback on their contributions or acknowledgement from scientists. In this study, students expressed high levels of interest in terms of value the students placed on their contribution to citizen science. However, the small predictive effect of contributions indicates that the students’ sense of ownership and contribution was not heartfelt. This apparent contradiction may suggest that, for the individual, the very idea of contributing to research may be seen as an ideal, rather than a concretely realized goal. A plausible explanation may be that the vast majority of students’ results simply confirmed findings that were previously included in the National Fish Atlas Database, and therefore, that students’ actual contributions to science were limited. In the Cell Spotting project, students strongly agreed that they were motivated for participating, but when asked whether they felt that they made a valuable contribution to research, students – especially older students – displayed lower values of confidence (Silva et al., 2016). In the ClimateWatch program, when first surveyed, most first year university students agreed that professional scientists use data collected by citizen scientists but after finishing the project, they were less convinced that scientists use data collected by citizen scientists. Besides, most students questioned the reliability of data (Mitchell et al., 2017).
The limited effect of gender

Even though previous studies have shown that female students are significantly more interested in biology than male students are (Blankenburg et al., 2016; Jansen et al., 2019), this was confirmed only for the first interest variable; a small effect, indicating that female students were more interested in detecting fauna by sequencing eDNA than male students were. However, it should be noted that the studies referenced measure general interest in academic subjects, that is, individual interest, whereas this study determines situational interest. Although they are experienced identically, the two concepts differ with regard to their situation-specificity. One possible explanation may be that the character of the lab activities in question may have been almost equally interesting to female and male students. For example, Holstermann, Ainley, Grube, Roick, and Bögeholz (2012) evaluated students’ situational interest in a biology dissection class, and found no or limited gender effect. Similarly, no gender differences were found for students’ interest in biodiversity-related citizen science projects (Kelemen-Finan et al., 2018).

The effect of program of study

The program of study was the most significant variable included in the model, as it had a moderate effect on the first interest variable, indicating that biotechnology students were more interested in sequencing eDNA than biology students. Conversely, the program of study had a small negative effect on the second interest variable, indicating that biotechnology students were less interested in the citizen science aspect. Thus, the findings suggest that when compared to biology students, biotechnology students are more interested in the method than the implications of conservation and biodiversity.
A student’s choice of a program of study in a Danish upper secondary school depends primarily on interests and requirements for higher education. It seems reasonable to conclude that their choices reflect individual interests in subject domains, as interest theory propose that people who enjoy and value a certain subject domain will search for similar activities. Research has shown that individual interest predicts situational interest (Durik & Harackiewicz, 2007; Holstermann et al., 2012; Tsai et al., 2008), as individual interest stimulates a positive and inquisitive orientation to a task, and may even help overcome obstacles when working (Fulmer & Frijters, 2011). Krapp (2002) has explained this in terms of “actualization of individual interest”, to indicate that in some situations, having an interest in something is prompted primarily by a person’s latent disposition, rather than situational features. In this study, biotechnology students may have been particularly likely to experience situational interest because of their identification with the subject matter, since real-time PCR is an important analytical method in food industry as well as in medical diagnostics. Besides, real-time PCR thermal cyclers are expensive equipment that schools cannot afford. The high mean value of interest suggests an affective “wow-effect” and fascination with a highly sophisticated experiment.

**Interactions among the interest variables**

The fact that the level of students’ interest in sequencing eDNA was high and a strong predictor of the three other interest variables suggests that the excitement of participating in a sophisticated experiment had a positive effect on students’ affective and value valences, regarding other aspects of the program. It is intriguing that the value the students placed on their contribution to citizen science had only a moderate effect on an interest in comparing methods of classification. Theoretically, communal value beliefs are attributed to a domain or activity that
includes working with and helping others (Brown et al., 2015). It seems likely that such communal value beliefs are not related to an interest in comparing two methods for taxonomy – neither in terms of domain nor in terms of type of value-related attributes. The two variables for comparing methods of classification have lower mean values, and one possible explanation may be that to some extent, students relate comparing methods to curriculum demands, and thus to some extend they are extrinsically motivated, although they are also interested. It is likely that students simultaneously attribute both intrinsic and extrinsic valence beliefs to the same object of interest, as research has shown that intrinsic and extrinsic motivation may be at work at the same time (Pintrich, 2000).

**Limitations**

This study has limitations why the conclusion should be taken with reservations. Importantly, this study covered only one topic. The data were entirely self-reported, and the findings are limited to cross-sectional data. Also, the analytical approach has some methodological limitations. Despite the use of structural modelling, where direction in the model is tested based on presumed cause-effect predictions about reality, it is important to point out that predictions are not the same as causal relationships. Interpretation of standardized regression coefficients is dependent on an accurately specified model because change of a single predictor could adjust all other coefficients and thus their interpretations. (Courville & Thompson, 2001).

Another point regarding construct validity is that although the instrument developed for this study was framed on the scale of measuring maintained situational interest, developed by Linnenbrink-Garcia and her colleagues (2010), it is uncertain whether it exclusively measures situational interest. Situational and individual interest are theoretically different constructs but phenomenological similar *in situ*, which means that it is difficult to distinguish between interest
that is simply a short-lived reaction and actualized individual interest that can be even stronger than the impact of situational cues (Knogler, 2017; Knogler et al., 2015). The time between perceived situational interest and its measurement is also critical. In this study, interest was measured at the end of a full-day program. The affective valences of interest are probably not captured well enough because emotions are fleeting. Thus, it might be the participants’ reflection on their emotions that is measured – not the affective state itself. Therefore, how situational the reported interest was, and how much individual interest was involved, are open questions. An important next step would be to develop a valid metric that distinguish among the phases of interest development.

**Conclusion**

This study aims to investigate upper secondary students’ interest in a citizen science program. The results indicate that students were strongly interested in the activities at the museum laboratory, and thus support previous studies of citizen science programs’ positive impact on student interest and motivation. However, one of the most important findings was that students’ own contributions in terms of collecting and analysing samples, had only a small predictive effect on their interest. For educators, the strongest conclusion derived from the findings may be that older students may not be particularly convinced that they are actually contributing to research, but that instead, they are taking part in a curricular learning design.
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Table 1

*Summary of students’ findings*

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>415</td>
</tr>
<tr>
<td>Amphibians</td>
<td>42</td>
</tr>
<tr>
<td>Crustaceans</td>
<td>7</td>
</tr>
<tr>
<td>Insects</td>
<td>8</td>
</tr>
</tbody>
</table>

*Note.* Students from 105 classes detected eDNA in 472 samples representing 17 species, over a period of 18 months. The most commonly found species of fish was the pike (*Esox lucius*), with 91 finds. The most frequently found amphibian was the common newt (*Lissotriton vulgaris*), with 28 finds.
Table 2

*Scales and items*

<table>
<thead>
<tr>
<th>No.</th>
<th>Scale and item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>It was exciting to detect faunas by sequencing eDNA</td>
</tr>
<tr>
<td>2</td>
<td>I enjoyed sequencing eDNA</td>
</tr>
<tr>
<td>3</td>
<td>I thought this was a boring activity</td>
</tr>
<tr>
<td>4</td>
<td>I think this topic is interesting</td>
</tr>
<tr>
<td>5</td>
<td>I would describe sequencing eDNA as very interesting</td>
</tr>
<tr>
<td>6</td>
<td>To be honest, I just don’t find eDNA interesting</td>
</tr>
<tr>
<td>7</td>
<td>This activity was fun to do</td>
</tr>
<tr>
<td>8</td>
<td>Sequencing eDNA is important because we help to map the distribution of species</td>
</tr>
<tr>
<td>9</td>
<td>It is exciting that our data can be used by researchers for mapping distribution of species</td>
</tr>
<tr>
<td>10</td>
<td>This task is important because our data can be used by others</td>
</tr>
<tr>
<td>11</td>
<td>Our data can help researchers map the wildlife in Danish lakes</td>
</tr>
<tr>
<td>12</td>
<td>Our data is relevant to others than just the class</td>
</tr>
<tr>
<td>13</td>
<td>It is important to me that others can benefit from our data</td>
</tr>
<tr>
<td>14</td>
<td>It was exciting to compare methods for the speciation of fish</td>
</tr>
<tr>
<td>15</td>
<td>It was interesting to try two different methods for identifying species</td>
</tr>
<tr>
<td>16</td>
<td>It is relevant to me to know different methods of speciation</td>
</tr>
<tr>
<td>17</td>
<td>It is important for me to know about different methods of speciation</td>
</tr>
<tr>
<td>18</td>
<td>It is important for me to be able to assess different methods of species determination</td>
</tr>
<tr>
<td>19</td>
<td>It is not relevant to me to know different methods of mapping species</td>
</tr>
</tbody>
</table>
Table 3

*Correlations, reliability, and descriptive statistics for all interest variables modelled in the current study*

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interest1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Interest2</td>
<td>.49**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Interest3</td>
<td>.52**</td>
<td>.38**</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Interest4</td>
<td>.46**</td>
<td>.36**</td>
<td>.46**</td>
</tr>
<tr>
<td></td>
<td>Factor loading</td>
<td>.56</td>
<td>.61</td>
<td>.85</td>
</tr>
<tr>
<td></td>
<td>Cronbach's alpha</td>
<td>.85</td>
<td>.88</td>
<td>.84</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>4.31</td>
<td>4.16</td>
<td>3.98</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>.63</td>
<td>.77</td>
<td>.96</td>
</tr>
</tbody>
</table>

*Note.* Interest1 = Interest in detecting fauna by sequencing eDNA. Interest2 = Value the students placed on their contribution to citizen science. Interest3 = Interest in comparing two methods of taxonomy. Interest4 = Valuing knowledge of different methods of taxonomy.

**p < .01.
Figure 1. Predictors of interest. Only significant standardized regression coefficient larger than .05 are shown. Study program = Biotech vs. Biology. Water = whether students took part in collecting water samples. DNA sample = whether students were able to detect eDNA in their samples. Interest1 = Interest in detecting fauna by sequencing eDNA. Interest2 = Value the students placed on their contribution to citizen science. Interest3 = Interest in comparing two methods of taxonomy. Interest4 = Valuing knowledge of different methods of taxonomy.

*p < .05. **p < .01. ***p < .001.