Can`t get (no) Basic Need satisfaction

Untersuchung von Maßnahmen zur Erfüllung der psychologischen Grundbedürfnisse am außerschulischen Lernort sowie in der Schule und ihre Auswirkungen auf die Motivationsqualität und den Wissenserwerb

Kumulative Dissertation im Fach Biologie
Universität Bielefeld
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Abgabetermin: 24.5.2018
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Zusammenfassung


Zum Aufbau eines kontrollierbaren asL an der Universität Bielefeld sowie einer Etablierung der Operationalisierung von bedürfnisunterstützenden Maßnahmen am asL wurden zwei Vorstudien durchgeführt (Vorstudie 1, N=231; Vorstudie 2, N=226). Diese dienten der


Der Ergebnisse der Interventionsstudien (Manuskript I und II) zufolge konnten SuS nur effektiv unterstützt werden, wenn zusätzliche Struktur am asL durch autonomieförderliches Lehrerverhalten vermittelt wurden. Die Untersuchungen in Manuskript II zeigten, dass autonomieförderliches Lehrerverhalten und Kompetenzförderung durch eine höhere Stufe an Struktur theoriekonform zur im Vergleich höchsten Ausprägung positiver Motivationsqualitäten führte. Die Wahrnehmung der Befriedigung einzelner Basic Needs ist
zusammenfassung

nachweisl ich stark von den anderen beiden abhängig (vgl. Dupont et al., 2014). Am asL
konnten Hinweise auf eine Verbindung von Autonomieförderung und Kompetenzförderung
gefunden werden. Diese Befunde sprechen für eine Abhängigkeit der Basic Needs
untereinander (vgl. Krapp & Ryan, 2002).

Die Neuheit der Lernumgebung ist typisch für alle asL. Offene Lernumgebungen, wie z. B.
„Free-choice“-Lernumgebungen (vgl. Falk, Dierking, & Adams, 2006) ermöglichen
selbstbestimmtes Lernen, indem sie die Möglichkeit für freie Bewegung innerhalb der
Lernumgebung und freie Auswahl der Lerngelegenheiten ermöglichen. Diese
Lernumgebungen sind am asL häufig zu finden und sind am formalen Lernort Schule
ebenfalls vorhanden (vgl. Bohl & Kucharz, 2010; Hartinger, 2005). Das Arbeiten in offenen
Lernumgebungen ermöglicht erkundendes Verhalten, kann allerdings belastend auf SuS
wirken (vgl. Tuovinen & Sweller, 1999) und zu Frustration und Verwirrung führen (Brown &
Campione, 1994; Hardiman, Pollatsek, & Weil, 1986). Neuheit auch am formalen Lernort
Schule potentiell in offenen Lernumgebungen, wie beim entdeckenden Lernen (Bruner, 1961,
1970) oder beim angeleiteten Entdecken (Moreno, 2004), sowie beim Anwenden neuer oder
komplexer Lernmethoden, wie dem Experimentieren (vgl. Ledermann, 2009; Schauble,
1990), wahrgenommen werden. Demnach stellte sich die Frage, ob sich die Erkenntnisse aus
den Studien am asL ebenfalls auf andere Lernorte anwenden ließen. Weitere Untersuchungen
fanden diesbezüglich am formalen Lernort Schule statt.

Um die beiden Lernorte weiter vergleichen zu können wurde zunächst die Operationalisierung
des autonomieförderlichen bzw. kontrollierenden Lehrerverhaltens am Lernort Schule geprüft
(Manuskript III, N=95). Dabei wurde mit originalen Objekten im Biologieunterricht –
Eurasischen Zwergmäusen (Micromys minutus) – gearbeitet. Es zeigte sich eine
theoriekonforme Wirkung auf die intrinsische Motivation der SuS. Autonomieunterstützendes
Lehrerverhalten führte zu einer höheren Ausprägung intrinsischer Motivation (Manuskript
III). Das Lehrerverhalten konnte am formalen Lernort Schule erfolgreich umgesetzt werden.

Die Unterstützung des Basic Needs nach sozialer Eingebundenheit im Kontext Schule wurde
ebenfalls in einer Unterrichtseinheit mit der Eurasischen Zwergmaus als Primärerfahrung
untersucht. SuS arbeiteten dabei entweder mit Laptops, den Mäusen oder mussten sich neben
dem Arbeiten mit den Mäusen im Unterricht zusätzlich, abseits des Unterrichts, um diese
pflegend kümmern. Dabei wurde die soziale Eingebundenheit der SuS zur unterrichtenden


Neben positiven Motivationsqualitäten ist der Wissenserwerb ebenfalls von zentraler Bedeutung für Unterricht am nicht-formalen und formalen Lernort. Die Selbstbestimmungstheorie der Motivation geht davon aus, dass motivierte und selbstbestimmt handelnde Personen sich Wissen differenziert und zusammenhängender aneignen (Deci & Ryan, 1993). In Manuskript IV konnte gezeigt werden, dass sich autonomiegeführte SuS mehr konzeptuelles Wissen aneigneten als kontrollierend unterrichtete SuS. Beim
Die folgenden sieben Manuskripte gehören zu dieser Promotionsschrift:


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<td>Außerschulische(r) Lernort(e)</td>
</tr>
<tr>
<td>BPNS</td>
<td>Basic Psychological Need Scale</td>
</tr>
<tr>
<td>CMoL</td>
<td>Contextual Model of Learning</td>
</tr>
<tr>
<td>GCT</td>
<td>Goal Content Theory</td>
</tr>
<tr>
<td>IMI</td>
<td>Intrinsic Motivation Inventory</td>
</tr>
<tr>
<td>KIM</td>
<td>Kurzskala intrinscher Motivation</td>
</tr>
<tr>
<td>PCS</td>
<td>Perceived Competence Scale</td>
</tr>
<tr>
<td>PSD</td>
<td>Perceived Self-Determination</td>
</tr>
<tr>
<td>QUA-LiS NRW</td>
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<tr>
<td>SDI</td>
<td>Selbstbestimmungsindex</td>
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<tr>
<td>SPSS</td>
<td>IBM Statistical Package for the Social Sciences</td>
</tr>
<tr>
<td>SRQ-A</td>
<td>Self-Regulation Questionnaire Academic</td>
</tr>
<tr>
<td>SuS</td>
<td>Schülerinnen und Schüler</td>
</tr>
<tr>
<td>TASCQ</td>
<td>Teacher as Social Context Questionnaire</td>
</tr>
<tr>
<td>TIMSS</td>
<td>Third International Mathematics and Science Study</td>
</tr>
</tbody>
</table>
1. Einleitung


Lernen findet nicht nur am Lernort Schule, sondern auch oder vor allem außerhalb der Schule statt und beeinflusst wiederum das Arbeiten und Lernen in der Schule (vgl. Eshach, 2007). Der Lernort Schule und asL unterscheiden sich in ihren Lernangeboten, Möglichkeiten und Herausforderungen (ebd.). Eine genauere Analyse der Lernorte ist demnach notwendig.

1.1 Außerschulischer Lernort


Ein Charakteristikum von asL ist i.d.R. deren Neuheit für die Besucher (Falk, 1983; Falk & Adelmann, 2003; Orion & Hofstein, 1994). Die wahrgenommene Neuheit scheint sich negativ auf motivational-affektive Aspekte des Lernprozesses auszuwirken (Rennie, 1994). In neuen und unbekannten Lernumgebungen mit hoher Neuheit fühlen sich SuS oft zunächst desorientiert (Falk, Martin, & Balling, 1978). SuS müssen sich aufgrund der Neuheit erst zurechtfinden (Gottfried, 1980) und können von ihren Aufgaben abgelenkt sein (Eshach,
1. Einleitung
1.2 Lernort Schule


1.2 Lernort Schule


Lernumgebungen, die starke Ähnlichkeit zur Neuheit am asL und ihrer Wirkung haben, sind auch abseits von Schülerbesuchen am asL bekannt u.a. an der Universität für Studierende

selbstbestimmtes Handeln, das nicht von äußeren Belohnungen oder Anreizen gesteuert wird (ebd.). Es handelt sich dabei um interessentbestimmte Handlungen, die um ihrer selbst willen ausgeführt werden (ebd.). SuS, die intrinsisch motiviert sind, beschäftigen sich vertieft mit Arbeitsmaterialien und eignen sich Wissen häufig differenzierter und zusammenhängender an (vgl. Deci & Ryan, 1993).

2. Theorie

2.1 Selbstbestimmungstheorie der Motivation


In der Causality Orientations Theory werden Aspekte der Persönlichkeit identifiziert, die für die Regulation von Verhaltensweisen und Erfahrungen grundlegend sind (Ryan & Deci, 2017). Die Theorie beschreibt charakteristische Wege, wie motivational relevante Informationen wahrgenommen und organisiert werden. Dabei handelt es sich um ein Konzept, das über Domänen, Zeit und Situationen hinweg angewendet werden kann (ebd.). Es gibt drei Kausalitätsorientierungen, die sich im Grad der wahrgenommenen Selbstbestimmung unterscheiden: Autonomieorientierung, Kontrollorientierung und impersonale Orientierung (ebd.). Jede Person verfügt über alle drei Orientierungen in unterschiedlicher Ausprägung (ebd.).

2.1.1 Organismic Integration Theory


Abbildung 1. Taxonomie der Regulationstypen, adaptiert nach Ryan and Deci (2017)

Im Fall der introjizierten Regulation wurde die Regulation bereits anteilig in das Selbst übernommen, so dass Handlungen nun keiner äußeren Anreize mehr bedürfen, aber der Handelnde sich dazu genötigt oder gezwungen fühlt, die Handlung auszuführen. Die Handlung wird ebenfalls als fremdgesteuert wahrgenommen (Deci & Ryan, 2000). Handlungen werden nur durchgeführt, um das Selbstwertgefühl zu stärken oder aufrechtzuerhalten. Die affektiven Folgen einer solchen Handlung sind im Falle der Durchführung Stolz bzw. Schuld im Falle einer Nichtdurchführung (Ryan & Deci, 2017). Handeln Personen introjiziert reguliert, so projizieren sie häufig die Einschätzung ihrer Handlung auf andere im Glauben, dass sie als Funktion ihres Handelns anerkannt oder missbilligt werden (ebd.).


2.1.2 Basic Need Theory

2.1 Selbstbestimmungstheorie der Motivation


2.1.2.1 Das Basic Need Autonomie

Autonomieerleben stellt einen entscheidenden Faktor für intrinsisch motivierte Tätigkeiten dar (Ryan & Deci, 2017). Handlungen, für die das Bedürfnis nach Autonomie nicht hinreichend befriedigt wird, kann ein instrumenteller und damit extrinsischer Charakter zugeordnet werden.


2.1.2.2 Das Basic Need Kompetenz

ein Verständnis darüber besitzen, wie die verfolgten Ziele erreicht werden können (Deci et al., 1991).


2.1.2.3 Das Basic Need soziale Eingebundenheit

2. Theorie
2.1 Selbstbestimmungstheorie der Motivation

Beziehung zur Lehrkraft von entscheidender Bedeutung. Ryan, Stiller und Lynch (1994) stellten fest, dass Kinder, die die Regulierung positiver, schulbezogener Verhaltensweisen vollständig verinnerlicht hatten, diejenigen waren, die sich sicher mit ihren Lehrern verbunden fühlten.


2.1.3 Cognitive Evaluation Theory

2. Theorie
2.1 Selbstbestimmungstheorie der Motivation


2.1.4 Relationship Motivation Theory

2.2 Der schulische und außerschulische Lernort

2. Theorie
2.2 Der schulische und außerschulische Lernort


<table>
<thead>
<tr>
<th></th>
<th>formales Lernen</th>
<th>Nicht-formales Lernen</th>
<th>informales Lernen</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Schule</td>
<td>in Institutionen außerhalb der Schule</td>
<td>Überall außerhalb der Schule</td>
</tr>
<tr>
<td>2</td>
<td>Vermittler (Lehrkraft) – formale Pädagogik</td>
<td>Vermittler (Lehrkraft oder ähnliches) – formale Pädagogik möglich</td>
<td>Kein Vermittler</td>
</tr>
<tr>
<td>3</td>
<td>evtl. unterdrückend</td>
<td>unterdrückend → unterstützend</td>
<td>unterstützend</td>
</tr>
<tr>
<td>4</td>
<td>Stark strukturiert</td>
<td>strukturiert ← unstrukturiert</td>
<td>unstrukturiert</td>
</tr>
<tr>
<td>5</td>
<td>geplant</td>
<td>Meist geplant</td>
<td>spontan</td>
</tr>
<tr>
<td>6</td>
<td>extrinsisch motiviert</td>
<td>extrinsisch ← intrinsisch</td>
<td>intrinsisch</td>
</tr>
<tr>
<td>7</td>
<td>obligatorisch</td>
<td>obligatorisch ← freiwillig</td>
<td>freiwillig</td>
</tr>
<tr>
<td>8</td>
<td>lehrergeleitet</td>
<td>lehrer- ← lernergeleitet</td>
<td>lernergeleitet</td>
</tr>
<tr>
<td>9</td>
<td>evaluiert</td>
<td>evaluiert ← nicht evaluiert</td>
<td>nicht evaluiert</td>
</tr>
<tr>
<td>10</td>
<td>sequentiell</td>
<td>nicht sequentiell</td>
<td>nicht sequentiell</td>
</tr>
<tr>
<td>11</td>
<td>Curriculum</td>
<td>-</td>
<td>kein Curriculum</td>
</tr>
<tr>
<td>12</td>
<td>wenige unbeabsichtigte Resultate möglich</td>
<td>unbeabsichtigte Resultate möglich</td>
<td>viele unbeabsichtigte Resultate</td>
</tr>
<tr>
<td>13</td>
<td>empirisch leicht überprüfbare Ergebnisse</td>
<td>weniger leicht überprüfbare Ergebnisse</td>
<td>weniger leicht überprüfbare Ergebnisse</td>
</tr>
</tbody>
</table>


Weiterhin kann aus Tabelle 1 abgeleitet werden, dass sich Arbeiten und Lernen an den jeweiligen Lernorten voneinander unterscheidet. Die unterschiedlichen Lernorte in den genannten drei Kategorien zu klassifizieren kann dazu beitragen, ein besseres Verständnis der Charakteristika der Lernorte zu erlangen. Die Spannweite innerhalb der nicht-formalen Lernorte ist dabei allerdings sehr groß, da Institutionen und die darin befindlichen Lernumgebung(en) unterschiedlich ausgestaltet und strukturiert sowie zu unterschiedlichen Graden interaktiv sind. Viele der Aspekte aus Tabelle 1 für das nicht-formale Lernen am asL
sind in Form eines Spektrums angegeben. Die potentielle Bandbreite zwischen den Ausprägungen der Aspekte könnte dabei ein Kontinuum des nicht-formalen Lernens beschreiben, das zwischen formalem und nicht-formalem Lernen zu verorten ist. Nicht-formales Lernen, das am asL stattfindet, kann daher, je nach Planung und Durchführung des Besuches sowie Verhalten des Vermittlers, eher als formal oder als informal charakterisiert werden.

Da der Fokus der Arbeit nicht auf informalem Lernen liegt, wird im Folgenden nur der formale schulische Lernort und der nicht-formale Lernort näher betrachtet werden.

**2.2.1 Formaler Lernort Schule und die Selbstbestimmungstheorie**


Im Folgenden wird vom Lernort Schule als formalem Lernort gesprochen.

2.2.2 nicht-formaler außerschulischer Lernort und die Selbstbestimmungstheorie

wahrscheinlicher machen. Sind nicht-formale Lernorte eher in Richtung informalem Lernen orientiert, könnten im Vergleich zum formalen Lernen am Lernort Schule potentiell positive Motivationsqualitäten unterstützt werden und eine Öffnung des Lernens zugunsten der Lerner erreicht werden. Besuche am asL können helfen, den stark formalisierten Umgang mit den SuS in der Schule aufzulösen und alternative Lern- und Sozialformen anzubieten (Killermann et al., 2013).


Im Folgenden wird vom asL als nicht-formalem Lernort gesprochen.
2.3 Schulbesuche an nicht-formalen Lernorten


2. Theorie
2.4 Neuheit der Lernumgebung


2.4 Neuheit der Lernumgebung

2.4.1 Auswirkung der Neuheit der Lernumgebung auf die Lehrkraft

Lehrkräfte und Tutoren spielen eine wichtige Rolle für das Arbeiten an formalen und nicht-formalen Lernorten. Lehrkräfte haben am asL nur eingeschränkte Kontrolle darüber, mit welchen Inhalten sich SuS beschäftigen (vgl. Burnett, Lucas, & Dooley, 1996; Griffin, 1998). Griffin und Symington (1997) legen nahe, dass Lehrkräfte sich eingeschüchtert fühlen könnten, wenn sie mit Klassen einen asL besuchen. Lehrkräfte sind dort häufig angespannt oder besorgt, SuS zu verlieren, keine Orientierung zu haben und Fragen nicht beantworten zu können (Dillon et al., 2006; Griffin & Symington, 1997). Das kann dazu führen, dass Lehrkräfte kontrollierendes Verhalten zeigen und aufgabenzentrierte Instruktionen nutzen (Dillon et al., 2006; Griffin & Symington, 1997). Lehrkräfte versuchen häufig durch stark aufgabenorientierte Instruktionen und restriktives Verhalten die SuS zu mehr fokussierter Aufmerksamkeit zu veranlassen (Griffin & Symington, 1997). Dieses kontrollierende Verhalten könnte sich negativ auf die Motivation auswirken und die Lernqualität beeinflussen. Dabei bietet das kontrollierende Verhalten viele Nachteile und die Aufgabenorientierung widerspricht anteilig der offenen Lernumgebung, die den asL ausmachen (vgl. Falk et al., 2006). Ob kontrollierendes Lehrerverhalten ein angemessenes Lehrerverhalten am asL ist, bleibt zu klären.


2.4.2 Auswirkung der Neuheit der Lernumgebung auf die SuS

Am asL zeigen SuS entdeckendes Verhalten, dass sich auf die Neuheit der Umgebung zurückführen lässt (Falk et al., 1978). Für SuS, die nicht vertraut mit der Lernumgebung waren, hatte exploratives Verhalten Vorrang vor konzeptuellem Lernen (ebd.). SuS befriedigten zuerst ihre Neugier und Unsicherheit in Bezug auf den neuen Lernort, bevor sie sich mit Lerngelegenheiten auseinandersetzten (ebd.). Ist die Ausprägung der Neuheit der Lernumgebung allerdings zu hoch, so kann dies zur Ablenkung von eigentlichen Aufgaben...


Besuche am asL befinden sich in dem Spannungsfeld, das sich zwischen Lehrkräften und SuS, nicht zuletzt durch die Neuheit der Lernumgebung, aufspannt. Um Planungssicherheit, fehlender Vorbereitung und der Neuheit der Lernumgebung Rechnung zu tragen sowie Lehrkräfte und SuS auf den Besuch am asL vorzubereiten, kann Struktur unterstützend wirken.
2.5 Struktur am außerschulischen Lernort


Struktur kann als ein Kontinuum angesehen werden, das von einem hohen Grad an Struktur bis zu einem kompletten Fehlen von Struktur (Chaos) reicht (Jang et al., 2010). Struktur ist gekennzeichnet durch die klare Kommunikation von Anforderungen und Erwartungen, das Aufzeigen von Wegen, wie Lernziele effektiv zu erreichen sind, und Zurverfügungstellung von Hilfestellungen bzw. Feedback (Skinner & Belmont, 1993). Chaos hingegen bedeutet, dass sich Lehrkräfte verwirrend und inkonsistent äußern, klare Regeln und Erwartungen nicht kommunizieren und Leistungen verlangt werden, ohne zu zeigen, wie SuS diese erreichen können (Jang et al., 2010). Struktur ist nicht zu verwechseln mit Kontrolle (Jang et al., 2010; Reeve et al., 2004). Kontrolle bzw. kontrollierende Behandlung von SuS zeichnet sich durch extrinsische Motivation, kontrollierend-instruktive Sprache (Befehle, Zurechtweisungen, Überwachung) und die Nichtberücksichtigung von Schülerinteressen aus (Reeve & Jang, 2006).


Feedback wirkt vor allem dann positiv, wenn es autonomiefördernder Art ist, d. h. wenn es sich auf Sachverhalte, die aus einer selbstbestimmten Handlung entstehen, bezieht und nicht kontrollierend hervorgebracht wird (Ryan, 1982). Die Zurverfügungstellung von Hilfe(n) und


2.6 Modellierung von Museumslernen im Contextual Model of Learning


2.6 Modellierung von Museumslernen im Contextual Model of Learning


2.6.1 Der soziokulturelle Kontext

Auch hier konnten positive Effekte auf das Lernen gezeigt werden (Crowley & Callanan, 1998; Koran, Koran, Dierking, & Foster, 1988; Wolins, Jensen, & Ulzheimer, 1992).

### 2.6.2 Der personale Kontext


### 2.6.3 Der gegenständliche Kontext


2.7 Verknüpfung des Contextual Model of Learning und der Selbstbestimmungstheorie

Das CMoL (s. Abb. 2, S.43) kann mit der SBT (s. 2.1, S. 20) verzahnt werden (Basten et al., 2014; s. Abb. 3). Die drei Kontexte des CMoL werden dabei durch jeweils eines der Basic Needs spezifiziert.


Um SuS zu motivieren, sich mit Lerngelegenheiten am asL auseinanderzusetzen, müssen die Basic Needs unterstützt werden. Das Bedürfnis nach Kompetenz ist erfüllt, wenn sich Personen in Interaktion mit der sozialen Umwelt erfolgreich fühlen (Ryan & Deci, 2017). Personen besitzen die angeborene Tendenz, neue und herausfordernde Erfahrungen machen zu wollen, um ihre Fähigkeiten zu erweitern, zu entdecken und zu lernen (Ryan & Deci, 2002). Kompetent fühlen sich Personen, die ein Verständnis darüber besitzen, wie bestimmte Ziele erreicht werden können (Deci et al., 1991). Eine Unterstützung der wahrgenommenen Kompetenz, in Form von Struktur (Jang et al., 2010; Skinner & Belmont, 1993), lässt sich aus dem gegenständlichen Kontext des CMoL mit den Faktoren Leitsysteme und Orientierung im
2.7 Verknüpfung des Contextual Model of Learning und der Selbstbestimmungstheorie


Das Bedürfnis nach sozialer Eingebundenheit bezieht sich auf den Wunsch von Personen, zu sozialen Gruppen oder Gemeinschaften zu gehören, zwischenmenschliche Verbindungen einzugehen und aufrechtzuerhalten (Ryan & Deci, 2017). Dies spiegelt sich im CMoL im soziokulturellen Kontext wider (s. Abb. 3). Die Förderung der sozialen Eingebundenheit am asL geschieht durch das Lernen in Gruppen und die Anteilnahme der Lehrkraft an den Aktivitäten und Erlebnissen der SuS am asL. Das Verhalten der Lehrkraft als Vermittler außerhalb der Gruppe kann hier ebenfalls zugeordnet werden.

Da sich eine Befriedigung der Basic Needs positiv auf die Motivation auswirkt, kann von einem indirekten Effekt auf den Faktor Motivation und Erwartungen im personalen Kontext ausgegangen werden.
3. Einbindung der Artikel

Motivation nimmt eine zentrale Stellung als eines der Qualitätsmerkmale guten Unterrichtes (Helmke, 2009) sowie für die Didaktik der Biologie ein (Berck & Graf, 2010; Killermann et al., 2013; Spörhase, 2013). In der Schulpraxis ist allerdings eine Abnahme der Motivation im Verlauf der Schullaufbahn (Berck & Graf, 2010; Prokop et al., 2007; Wild et al., 2006) und ein fehlender Fokus der Lehrenden auf motivationale Merkmale der SuS zu verzeichnen (vgl. Jansen et al., 2013). Eine Möglichkeit zur Motivationsförderung bietet sich im Biologieunterricht durch das Arbeiten mit lebenden Tieren (Hummel, 2011; Hummel & Randler, 2012; Prokop, et al., 2007). Die Unterstützung der Basic Needs durch die Lehrkräfte und die Lernumgebung kann die Schülermotivation ebenfalls positiv beeinflussen (Jang et al., 2010; Reeve, 2002). Die Befriedigung der Basic Needs Autonomie, Kompetenz und soziale Eingebundenheit führt sowohl zu positiven Motivationsqualitäten als auch Wohlbefinden (Chirkov et al., 2003; Deci & Ryan, 2000; Ryan & Deci, 2000b; Vansteenkiste & Ryan, 2013). Die Förderung der Basic Needs könnte darüber hinaus eine Möglichkeit darstellen, um die Forderungen des Referenzrahmens der QUA-LiS NRW umzusetzen.

Die Publikationen setzen sich dabei mit Interventionen zur Unterstützung von zumindest einem der Basic Needs oder einer Kombination dieser auseinander und untersuchen die Wirkung auf die Motivation der SuS. Weiterhin wird in zwei Publikationen (Manuskript IV und VI) die Wirkung von positiven Motivationsqualitäten auf den Wissenserwerb der SuS untersucht. Die Studien wurden anteilig an einem nicht-formalen asL (Manuskript I und II) und dem formalen Lernort Schule (Manuskript III-VII) durchgeführt.

3.1 Nicht-formaler Lernort Mitmachausstellung

Das Verhalten von Besuchern und ihr Umgang mit Lerngelegenheiten bzw. Lernangeboten am asL werden durch die Neuheit der Lernumgebung beeinflusst (Falk et al., 1978). Im Rahmen von Besuchen am asL kann es bei Besuchern zu Unsicherheit (ebd.), Neugier (Falk & Adelmann, 2003; Lewalter & Geyer, 2009; Ramey-Gassert et al., 1994; Rice & Feher, 1987), Aufregung (Wellington, 1990) und Desorientierung kommen (Griffin & Symington, 1997; Hofstein & Rosenfeld, 1996). In einer neuen Lernumgebung mit hoher Neuheit verbringen SuS oft zunächst viel Zeit damit, sich zurechtzufinden und zufällig nach Stimuli zu suchen (Gottfried, 1980). In zwei Vorstudien (Vorstudie 1, N=231; Vorstudie 2, N=226) wurde ein asL in Form einer Mitmachausstellung aufgebaut und bedürfnisunterstützende
Maßnahmen für Autonomie (Lehrerverhalten) und Kompetenz (Struktur) operationalisiert, entwickelt und erprobt. Beim Lehrerverhalten wurde zwischen kontrollierendem (Untersuchung 1) und autonomieförderlichem Verhalten (Untersuchung 2) variert. Die zwei entwickelten Stufen Struktur, Basis- und Zusatzstruktur, unterschieden sich in der Elaboriertheit der eingesetzten Strukturelemente.

Im Rahmen von Manuskript I wurde der Einfluss von Lehrerverhalten und Struktur am asL auf die Schülermotivation in zwei Untersuchungen geprüft. Dabei besuchten Schulklassen eine Mitmachausstellung zum Thema Bewegung in den Räumlichkeiten der Universität Bielefeld. In Untersuchung 1 wurde die Wirkung von kontrollierendem Lehrerverhalten, das für den Schulalltag typisch ist (Reeve et al., 1999), untersucht. Dabei nutzten Lehrkräfte kontrollierende Kommunikationsstile, ließen keinen Spielraum für individuelle Gestaltungsmöglichkeiten und kontrollierten das Verhalten der SuS, um unerwünschte Verhaltensmuster zu verhindern und wünschenswerte Verhaltensweisen mit externen Anreizen zu unterstützen (Assor et al., 2002; Reeve et al., 1999).

Die bereitgestellte Struktur kann die Kompetenzwahrnehmung der SuS unterstützen (Basten et al., 2014; Dupont et al., 2014; Grolnick & Ryan, 1987; Vansteenkiste et al., 2012) und Desorientierung reduzieren, die an neuen unbekannten Lernorten auftritt (vgl. Connell & Wellborn, 1991; Skinner Furrer, Marchand, & Kindermann, 2008). Dabei könnte die Basisstruktur möglicherweise nicht ausreichen, um das Bedürfnis der SuS nach Kompetenz zu unterstützen, während die Zusatzstruktur die Wahrnehmung von Kompetenz adäquat unterstützt. Da die Wahrnehmung von Kompetenz eine Voraussetzung für das Erleben positiver Motivationsqualitäten ist, wird angenommen, dass Zusatzstruktur positive Motivationsqualitäten fördert. So kann die folgende Hypothese abgeleitet werden:

**H1** Zusatzstruktur in einem nicht-formalen Lernumfeld wirkt sich positiv auf die intrinsische Motivation der SuS im Vergleich zu Basisstruktur aus.

In Untersuchung 2 wurde autonomieförderliches Lehrerverhalten eingesetzt. Ansonsten wurde die Studie identisch durchgeführt. Dabei nehmen autonomiefördernde Lehrkräfte Wünsche und Bedürfnisse der SuS ernst, verwendeten autonomieförderliche Kommunikationsstile und räumten Wahlmöglichkeiten ein (Jang et al., 2010; Su & Reeve, 2011). Maßnahmen zu autonomieförderlichem Lehrerverhalten könnten selbstbestimmtes Handeln der SuS fördern und die Motivation der SuS positiv beeinflussen (Martinek, 2010; Reeve, 1998).
3. Einbindung der Artikel
3.2 Formaler Lernort Schule

In Untersuchung 2 wurde die gleiche Hypothese beibehalten:

**H2** Zusatzstruktur in einem nicht-formalen Lernumfeld wirkt sich positiv auf die intrinsische Motivation der SuS im Vergleich zur Basisstruktur aus.

Die Hypothesen 1 und 2 werden in **Manuskript I** (s. 5.1, S.66) geprüft.

In **Manuskript II** wurden das Lehrerverhalten und die Struktur in einem 2x2 Design variiert, um das Zusammenspiel der beiden Faktoren, Autonomie und Kompetenz, genauer zu untersuchen. Hospel und Galand (2016) stellen fest, dass Autonomieunterstützung und Struktur als komplementäre und sich gegenseitig unterstützende Dimensionen betrachtet werden könnten. Diese Befunde sind vergleichbar zu vorherigen Untersuchungen zum Engagement der SuS (vgl. Jang et al., 2010; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Vansteenkiste et al., 2012). Daraus wurde folgende Forschungsfrage abgeleitet:

**F1** Wie beeinflussen das Lehrerverhalten während einer Exkursion zum asL, die Struktur der Ausstellung und die Interaktion zwischen Lehrerverhalten und -struktur die intrinsische Motivation der SuS?

Die Forschungsfrage wird in **Manuskript II** (s. 5.2, S.77) untersucht.

**3.2 Formaler Lernort Schule**


**Manuskript III** diente zur Überprüfung der Operationalisierung des autonomieförderlichen bzw. kontrollierenden Lehrerverhaltens am Lernort Schule. Bei dem untersuchten Unterricht handelte es sich um eine Unterrichtseinheit zur Anpassetheit der Eurasischen Zwergmaus (*Micromys minutus*). Biologieunterricht mit lebenden Tieren kann die Schülermotivation unterstützen (Hummel, 2011; Hummel & Randler, 2012; Prokop et al., 2007). Die Auswirkungen von autonomieförderlichem Lehrerverhalten im Vergleich zu kontrollierendem Lehrerverhalten auf motivationale Zielvariablen am formalen Lernort wurden untersucht. Die zugehörige Hypothese lautet:

**H3** Autonomiefördernder Biologieunterricht wirkt sich positiv auf die intrinsische Motivation der SuS aus.

Hypothese 3 wird in **Manuskript III** (s. 5.3, S.88) untersucht.

1981) könnten Geschlechterrollen bei der Interaktion mit gleichgeschlechtlichen Lehrkräften aber positive Auswirkungen auf die Schülerinnen bzw. Schüler haben. Daraus wurde folgende Forschungsfrage abgeleitet:

**F2** Gibt es Unterschiede in der Wahrnehmung von sozialer Eingebundenheit zwischen Schülern gegenüber ihren Lehrerinnen bzw. zwischen Schülerinnen gegenüber Lehrern?


**F3** Kann die Pflege lebender Tiere die soziale Beziehung zwischen Schülerinnen und Lehrern bzw. Schülern und Lehrerinnen verbessern?

Die Forschungsfragen 2 und 3 werden in **Manuskript V** (s. 5.5, S. 109) untersucht.


**H4** Die Bereitstellung von informativem tutoriellem Feedback während des Experimentierens im Biologieunterricht fördert intrinsische Motivationsqualitäten.

Die Hypothese 4 wird in Manuskript VI (s. 5.6, S.133) untersucht.

Die gegenseitige Abhängigkeit der Basic Needs untereinander (Krapp & Ryan, 2002) lässt vermuten, dass sich autonomieförderlicher Unterricht ebenfalls positiv auf die Kompetenzwahrnehmung auswirkt. Ein eher kontrollierender Unterricht müsste daher eine unterminierende Wirkung auf die Kompetenzwahrnehmung der SuS haben. Die zugehörige Hypothese lautet:

H5 SuS, die autonomieförderlich unterrichtet werden, nehmen sich in der durchgeführten Unterrichtseinheit als kompetenter wahr als SuS, deren Lehrkraft sich kontrollierend verhält.


H6a Die Autonomiewahrnehmung der SuS in der durchgeführten Unterrichtseinheit ist ein Prädiktor ihrer Kompetenzwahrnehmung in dieser Unterrichtseinheit.

H6b Die Kompetenzwahrnehmung der SuS in ihrem regulären Biologieunterricht ist ein Prädiktor ihrer Kompetenzwahrnehmung in der durchgeführten Unterrichtseinheit.

H6c Das Vorwissen der SuS über einen Unterrichtsgegenstand ist ein Prädiktor ihrer Kompetenzwahrnehmung in der durchgeführten thematisch entsprechenden Unterrichtseinheit.

Die Hypothesen 5 und 6(a-c) werden in Manuskript VII (s. 5.7, S.158) untersucht.

davon aus, dass motivierte und selbstbestimmt handelnde Personen sich Wissen differenzierter und zusammenhängender aneignen (Deci & Ryan, 1993).


H7a Autonomiegeförderte SuS eignen sich mehr Reproduktionswissen an als kontrollierend unterrichtete SuS.

H7b Autonomiegeförderte SuS eignen sich mehr konzeptuelles Wissen an als kontrollierend unterrichtete SuS.

Die Hypothesen 7(a-b) werden in Manuskript IV (s. 5.4, S.100) untersucht.

Mit Manuskript VI wird die Intervention zum Experimentieren im Rahmen des Entdeckenden Lernens erneut aufgegriffen. Entdeckendes Lernen (Bruner, 1961, 1970) könnte positive Qualitäten der Motivation in Problemlösungsprozessen durch die Wahrnehmung von Autonomie unterstützen, da es sich um eine offene Lernumgebung handelt und Handlungen selbstbestimmt durchgeführt werden können. Mit Entdeckendem Lernen assoziierte Lernumgebungen benötigen möglicherweise Unterstützung (vgl. Kirschner et al., 2006; Mayer, 2004; Wirth et al., 2008). Lehrkräfte in Lernumgebungen, die sich am

**H8** Die Bereitstellung von informativem tutoriellem Feedback während des Experimentierens im Biologieunterricht unterstützt den Wissenserwerb.

Die Hypothese 8 wird in Manuskript VI (s. 5.6, S.133) untersucht.
4. Methodische Umsetzung

4.1 Stichproben


4.2 Messinstrumente

In den Manuskripten kam eine Vielzahl von Instrumenten zum Einsatz. Nach der Beschreibung der Ratingskalen und Reliabilitäten der Skalen werden sie nach den zu erfassenden Bereichen angeordnet vorgestellt. Die verwendeten Messinstrumente wurden auf einer fünfstufigen Ratingskala erfasst (0 = „stimmt gar nicht“ bis 4 = „stimmt völlig“). Mit Ausnahme der bereits übersetzten Kurzskala intrinsischer Motivation und des Self-Regulation Questionnaire Academic wurden die Messinstrumente durch die Übersetzung ins Deutsche adaptiert. Die Reliabilitäten der Skalen bzw. Subskalen in Form des Cronbachs Alpha waren mit einer Ausnahme (Manuskript VI, $\alpha = 0,48$) zufriedenstellend bis sehr gut. Die Werte lagen zwischen $\alpha = 0,61$ und $\alpha = 0,90$. Wissenstests enthielten geschlossene und offene Items. Geschlossene Multiple-Choice-Items wurden dabei mit „0“ Punkten für eine falsche bzw. „1“ Punkt für eine korrekte Antwort bewertet. Bei offenen Items wurden, anhand eines Erwartungshorizontes, bei einer falschen Antwort „0“ Punkte, bei einer teilweise korrekten Antwort „1“ Punkt und bei einer korrekten Antwort „2“ Punkte vergeben. Die Interrater-Reliabilität in Form des Kappa-Koeffizienten war gut ($\kappa = .90$).

Die Basic Needs wurden getrennt mit den folgenden Instrumenten in Abhängigkeit der Fragestellung im Vortest und/oder im Nachtest erhoben. Zur Erfassung der Autonomiewahrnehmung der SuS wurde entweder die Subskala „Autonomie“ der Basic Psychological Need Scale (BPNS-A; Baard, Deci, & Ryan, 2004) oder der Fragebogen
Perceived Self-Determination (PSD; Reeve et al., 2003) eingesetzt. Beide Fragebögen wurden als Implementationskontrolle verwendet. Die wahrgenommene Kompetenz wurde entweder mit der Subskala „Kompetenz“ der Basic Psychological Need Scale (BPNS-K; Baard et al., 2004) oder mit der Perceived Competence Scale (PCS; Williams & Deci, 1996) erfasst. Für die Erhebung der sozialen Eingebundenheit kam die Subskala „Eingebundenheit“ des Intrinsic Motivation Inventory (IMI-E; McAuley, Duncan, & Tammen, 1989; Ryan, 1982; Ryan, Connell, & Plant, 1990) zum Einsatz.

Tabelle 2. Übersicht über die in den Manuskripten angewendeten Fragebögen

<table>
<thead>
<tr>
<th>Manuskript</th>
<th>Vortest</th>
<th>Nachtest</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>BPNS - A (<em>Untersuchung 2</em>), TASCQ, IMI</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>IMI</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>SRQ-A</td>
<td>KIM</td>
</tr>
<tr>
<td>IV</td>
<td>Wissenstest</td>
<td>Wissenstest</td>
</tr>
<tr>
<td>V</td>
<td></td>
<td>IMI - Eingebundenheit</td>
</tr>
<tr>
<td>VI</td>
<td>SRQ-A, Wissenstest</td>
<td>Wissenstest, TASCQ, IMI</td>
</tr>
<tr>
<td>VII</td>
<td>Wissenstest, PCS, PSD</td>
<td></td>
</tr>
</tbody>
</table>

**4.3 Designs**

4. Methodische Umsetzung
4.3 Designs

4.3.1 Unterrichtseinheiten

Die Unterrichtseinheiten der jeweiligen Intervention unterscheiden sich zwischen den Manuskripten und werden im Folgenden kurz dargestellt und in die Kernlehrpläne von Gymnasium sowie Gesamt- und Realschule eingeordnet. Je nachdem, welche Schultypen an der jeweiligen Untersuchung teilnahmen.

4.3.1.1 Nicht-formaler Lernort

Mitmachausstellung zum Themenbereich Bewegung


4.3.1.2 Formaler Lernort Schule

Unterricht zum Thema Eurasische Zwergmaus (Micromys minutus)

wurde die Einheit um eine Stunde erweitert. Die Einheit beinhaltete eine Stunde zur Morphologie, zum Kletterverhalten, zur Konstruktion von Nest und Futterwahl sowie zum natürlichen Habitat und der geographischen Verbreitung.

Unterricht mit den Vogelflugkästen


Unterricht zum Thema Ernährung


4.3.2 Treatments

4.3.2.1 Autonomieförderliches und kontrollierendes Lehrerverhalten

In den Manuskripten II, III, IV und VII variieren das Lehrerverhalten zwischen den Treatments. Dabei kann zwischen dem autonomieförderlichem (A) und kontrollierendem Lehrerverhalten (K) unterschieden werden. Hier soll nur ein kurzer Überblick über die Operationalisierung gegeben werden. Diese wurde in Manuskript VII erweitert (s. 5.7, S. 158). Zur Standardisierung der Autonomieförderung bzw. der Kontrolle wurden u.a. die von...

4.3.2.2 Basisstruktur und Zusatzstruktur

4. Methodische Umsetzung
4.3 Designs

4.3.2.3 Arbeiten mit Laptop, Arbeiten mit Zwergmäusen und Pflege für Zwergmäuse


4.3.2.4 Basisfeedback und Zusatzfeedback

die Verantwortung für das Nachdenken an den SuS "zurückzuwerfen" (Van Zee & Minstrell, 1997). Dies kann die SuS ermutigen, ihre eigenen Fragen selbstständig zu bearbeiten und ihr Denken für die Lehrkraft sichtbar zu machen. Dadurch können Ansatzpunkte für Lehrerfeedback gefunden werden.

Tabelle 3. Übersicht über die in den Manuskripten eingesetzten Unterrichtseinheiten und Treatments

<table>
<thead>
<tr>
<th>Manuskript</th>
<th>Unterrichtseinheit</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Mitmachaussstellung; „Bewegungsapparat von Mensch und Tier“</td>
<td>2x2 Design; „S“ / „S+“ &amp; „A“ / „K“</td>
</tr>
<tr>
<td>III</td>
<td>„Anangepasstheit der Eurasischen Zwergmaus an ihren Lebensraum“</td>
<td>„A“ / „K“</td>
</tr>
<tr>
<td>IV</td>
<td>„Anangepasstheit der Eurasischen Zwergmaus an ihren Lebensraum“</td>
<td>„A“ / „K“</td>
</tr>
<tr>
<td>VI</td>
<td>„Warum können Vögel fliegen“</td>
<td>„F“ / „F+“ , autonomieförderliches Lehrerverhalten</td>
</tr>
<tr>
<td>VII</td>
<td>„Bau und Leistungen des menschlichen Körpers“</td>
<td>„A“ / „K“</td>
</tr>
</tbody>
</table>
4.4 Auswertung und Statistik


5. Manuskripte

5.1 Manuskript I: Studies on the effects of structure in the context of an autonomy-supportive or a controlling teacher behaviour on students' intrinsic motivation

Zeitschrift: Learning and Individual Differences (2018)

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5. Manuskripte
5.1 Manuskript I: Studies on the effects of structure in the context of autonomy-supportive or a controlling teacher behaviour on students' intrinsic motivation

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ARTICLE INFO
Keywords: Structure, Competence, Self-Determination Theory, Contextual Model of Learning, Motivation, Teacher behavior

ABSTRACT
Trips to extracurricular settings can foster exploration and may promote self-determined learning. Students’ motivation is an essential characteristic of self-determined and successful learning processes in extracurricular settings. The Self-Determination Theory argues that the quality of students’ motivation is inter alia dependent on the fulfillment of the basic need for competence. Extracurricular settings are potentially unstructured and may therefore frustrate students’ perception of competence. Teachers tend to show restrictive behavior and use teacher-led and task-oriented instructions in non-formal settings. These findings were used to design a typical situation in an extracurricular setting. We hypothesized that the provision of supplementary structure improves students’ quality of motivation by supporting their need for competence. In our 1st study, 198 students (Momp = 11.96, SDomp = 1.11, Rump = 4.97) visited an exhibition dealing with locomotor systems. Two degrees of structure were implemented: basic and supplementary structure. Students’ motivation was assessed at the end of the visit. The results of study 1 did not show the assumed positive effect of supplementary structure on students’ motivation. By closely analyzing our study design, we suspected that the implemented teacher behavior in extracurricular settings might not have been appropriate. Consequently, we conducted a 2nd study N = 189; Momp = 12.45, SDomp = 1.49, Rump = 4.69) that again examined the effect of two degrees of structure on students’ quality of motivation. This time, we implemented autonomy-supportive teacher behaviors. Otherwise, the study was conducted identically. In study 2, we found beneficial effects of supplementary structure on students’ motivation. Comparing both studies, additional structure showed only positive effects on students’ motivation, when teachers acted autonomy-supportively.

1. Introduction

Because extracurricular settings such as museums often facilitate authentic encounters (Griffin, 1998), freedom of choice (Bamberger & Tal, 2006) and possibilities for self-determined learning (Wilde & Urbahn, 2008), they may provide a valuable opportunity to contribute to students’ intrinsic motivation during their learning processes. At the same time, learners in extracurricular settings may experience disorientation (Griffin & Symington, 1997; Hofstein & Rosenfeld, 1996; Remée & McClafferty, 1997) in these exceedingly multifaceted learning settings (Fildi & Anderson, 1992; Remée, 1994), potentially resulting in missed learning opportunities (Falk & Balling, 1982; Gottfried, 1980; Griffin & Symington, 1997). To avoid feelings of disorientation and excessive demand as well as time-delayed engagement with the exhibits in extracurricular settings, orientation can be facilitated through structure. The provision of structure plays a key role in terms of promoting students’ perception of competence (Basten, Meyer-Ahrens, Fries, & Wilde, 2014; Grolnick & Ryan, 1989) and might have an influence on students’ motivation (Connell & Wellborn, 1991; Deci & Ryan, 2000; Prokop, Tuncer, & Eyvanīsfāk, 2007; Ryan & Deci, 2007; Skinner, Purrer, Marchand, & Kindermann, 2008). The basic need for competence and its effects on motivation are anchored in Self-Determination Theory (SDT; Deci & Ryan, 2000; Ryan & Deci, 2017). Provisions of structure that support the perception of competence can be derived from the SDT (Deci & Ryan, 2000; White, 1959). Structure in the sense of the SDT supports students in their interactions with their surroundings. Thereby, it may facilitate successful and effective interactions with learning materials in unfamiliar learning environments. In extracurricular settings, this may help students achieve a balance between the requirements of the tasks and their individual abilities (Deci & Ryan, 1993).

To date, there are no theoretical approaches that are tailored to the specific requirements of extracurricular settings for school class visits (Eichbach, 2007; Falk and Stormsberge, 2005) consider it critical to apply models of formal learning to learning in extracurricular settings. Falk and Decking’s (2000) Contextual Model of Learning (CMoL) is a model...
5. Manuskripte

5.1 Manuskript I: Studies on the effects of structure in the context of an autonomy-supportive or a controlling teacher behaviour on students’ intrinsic motivation

for museum learning. Three contexts are considered important for museum learning: the personal, the physical and the socio-cultural context (Falk & Dierking, 2000). The CMol's holistic view on learning represents a construction of knowledge. This learning is dependent on the interaction of the three contexts with one another. Still, some relevant aspects for school learning in extracurricular settings are missing (Esbach, 2007). Esbach (2007) argues that the model insufficiently refers to the required balance of cognitive and affective factors in non-formal settings. Augmenting the contexts of the CMol, with the SDT might help complement the CMol, regarding affective aspects and emphasize certain instructional aspects more explicitly. The SDT in particular emphasizes the prerequisites for favorable qualities of motivation (Deci & Ryan, 1985, 2000, 2002). Moreover, it specifies the operationalization of structure in terms of the basic need for competence and may therefore present a valuable opportunity to contribute to successful learning processes in non-formal learning settings in the CMol's physical context. Accordingly, the provision of structure might prevent students from losing their focus on learning opportunities, avoid disorientation and helplessness and reduce perceived novelty. Consequently, structure might improve the quality of a typical school class visit. Based on the SDT and the CMol, we conducted a study investigating two degrees of structure, basic and supplementary, for a described three situations in a school class visit. It refers to the provision of structure affected structural and orientation aids as well as the design of the exhibition. We operationalized supplementary structure as communicating clear expectations towards students, offering guidance systems, advance organizers as well as orientation aids and a strong linkage of students’ tasks and overall design. Basic structure did not contain these elements.

Our aim was to investigate these types of structure in the context of a typical school class visit to an extracurricular setting. The teacher behavior was therefore characterized by task-orientation, directives and direct instructions in the first study (Griffin, 1994; Griffin & Simmons, 1997). In the second study, we took the teacher behavior into consideration. The implemented teacher behavior in study 1 is assumed to be controlling and might have an impact on the quality of motivation to such an extent that the variation of structure might be confounded. Therefore, we investigated the described two types of structure again in the context of autonomy-supportive teacher behavior. This behavior was characterized by non-controlling language and the acknowledgment of the students’ perspective.

2. Theory

2.1. Non-formal learning settings

The CMol by Falk and Dierking (2000) is a holistic theory that explains and frames learning in museums. According to Falk and Dierking (2000), the term museum learning describes learning in various extracurricular settings, such as zoos, aquariums, botanical gardens, interactive exhibitions and – of course – museums. Yet, it does not especially focus on museum learning for school class visits. In general, two types of learning environments may be distinguished: formal and informal (Esbach, 2007). The most common formal setting is school, which is teacher-led and highly structured. Informal settings, on the other hand, are unstructured, learner-led and can potentially occur in everyday situations. According to Dierking (1991) and Esbach (2007), a sharp distinction between formal and informal learning is inappropriate. Museum learning appears in an extracurricular setting that refers to learning outside the classroom, yet is at the same time pre-arranged and structured. Often, there are working materials or guides that can be ascribed to situations of formal learning. Esbach (2007) described class visits to museums as non-formal. Learning in non-formal settings is not easy to describe, since working in these settings may be more or less student-led and more or less structured depending on the teacher, guide and visited institution. Taking this into account, they may still offer motivation for learning that is intrinsic to the learner (Esbach, 2007). For school class visits to extracurricular settings, students’ learning is quite similar to formal learning. Teachers tend to transfer priorities such as cognitive achievement, teaching goals and teacher-led instructions from formal to non-formal settings (Griffin, 1994; Griffin & Simmons, 1997; Levalier & Geyer, 2009). In reference to Esbach (2007), the CMol does not emphasize all aspects of non-formal learning adequately, especially for school class visits. On one hand, the goals and structure of school trips need to be accentuated. On the other hand, affective domains need to be emphasized more systematically (Esbach, 2007; Raudler, Ig & Kern, 2005). Both issues might be addressed by complementing the CMol with the SDT. The SDT has been successfully applied to several domains, including education (Deci & Ryan, 2000). According to the SDT, goals and structure are intertwined with the perception of competence and intrinsic motivation. In the following paragraph, the SDT is linked with the CMol.

2.2. The contextual model of learning and the self-determination theory in the context of non-formal learning settings

The CMol is a framework for learning in extracurricular settings. The CMol, takes a holistic view of learning in museums to take the complexity of museum learning into consideration. It refers to museum learning in free-choice settings (Falk & Ederking, 2005; Falk & Storksdiek, 2005). Learning in these settings is considered a dialogue between the individual and the environment. According to the CMol, working and learning in these environments is dependent on three contexts: the personal, the socio-cultural and the physical (Falk & Storksdiek, 2005). The personal context deals with motivation, interests and previous knowledge of individual visitors as well as choice and control when interacting with the exhibits. The socio-cultural context includes cultural values and social relationships (Falk & Storksdiek, 2005). It focuses on interactions between visitors as well as interactions between visitors and museum staff, e.g. museum guides (Falk & Storksdiek, 2005). The physical context addresses characteristics of the setting and the design of an exhibition (Falk & Storksdiek, 2005). It describes the availability of advance organizers, orientation aids and the overall design of the settings (Falk & Storksdiek, 2005). Our study focuses on the physical and the personal context.

According to Esbach (2007), the CMol does not emphasize all aspects of non-formal learning adequately, especially for school class visits. The SDT can supplement the CMol as it takes affective factors into special consideration. The three contexts can be attributed to the basic needs anchored in the SDT, thereby enabling the operationalization of the contexts. In this way, non-formal settings may be studied. The personal context can be attributed to the basic need for autonomy, the socio-cultural context to the basic need for relatedness and the physical context to the basic need for competence (Bessen et al., 2014). The contexts as they are perceived by the visitors may then be empirically tangible.

In the SDT, Deci and Ryan (2002) state that the satisfaction of the mentioned basic psychological needs plays an essential role in fostering positive qualities of motivation (Deci & Ryan, 2002). Since learning in non-formal settings may be unstructured, the students might be overwhelmed by the possibilities of the learning environment. They might feel disoriented and may feel that they are unable to meet the perceived expectations (Falk & Ballinger, 1982; Gottfried, 1980; Griffin & Simmons, 1997; Hoferin & Rosenfeld, 1986; Bremi & Mcllstraff, 1995). As a result, the fulfillment of the basic need for competence might be impaired. Consequently, the need for competence should be focused in the design of appropriate learning settings. The need for competence is satisfied when individuals feel successful and effective in their interaction with their environment (Deci & Ryan, 2002). Individuals have the innate tendency to create new and challenging experiences to enhance their abilities, discover and learn (Ryan & Deci, 2000). Non-formal learning settings enable students to discover,
explore (Bamberger & Tal, 2006) and offer opportunities for self-determined learning (Wilde & Urhahne, 2008). Since students can choose tasks that match their skills adequately from a range of possibilities, these learning settings seem suitable for fostering students’ perception of competence. According to the SDT, the frustration of students’ need for competence can have negative effects on their intrinsic motivation (Deci & Ryan, 2002). Frustration of the students’ need for competence may be prevented by providing structure. In the following paragraph, provisions of competence-supportive structures in the sense of the SDT in extracurricular settings will be depicted in more detail.

2.3. Supporting competence in the context of non-formal learning settings

The novelty of extracurricular settings and the range of possibilities can cause curiosity among learners (Leuwalter & Geyer, 2009). An open and new space may at the same time be perceived as unstructured and could cause learners to lose their focus amid learning opportunities (Falk & Balling, 1982; Gottfried, 1985; Griffith & Symington, 1999; Hofstein & Rosenfeld, 1986). If visitors feel disoriented, this might affect their ability to focus on exhibits (Falk, 1983; Orline, Hofstein, & Mazor, 1986). Teachers know of the problematic effects of novel and distracting environments which may hinder work on given tasks (Gottfried, 1983), for example, through peer affiliation which may be perceived as more important to students than working on the given tasks (Falk & Balling, 1982; Martin, Falk, & Balling, 1981). One of the problems of non-formal settings, especially novel ones, is preparation towards the visit and the working materials (Anderson & Lucas, 1997; Bigwood, 1985; Falk & Dierking, 2000; Gilbert & Priest, 1997; Griffith, 2004). Preparation towards a novel learning environment enables students to evaluate which work orders are suitable (Griffith, 1998). If visiting students are not prepared in terms of strategies and capacities towards the non-formal setting, their learning may suffer. As students’ actions and learning are determined, among other factors, by curiosity and novelty, which may vary individually, it is not surprising that the effects of visits to non-formal settings on learning are diverse (Borun & Flamer, 1982; Griffith, 2004; Koran, Koran, & Illus, 1989; Lewalter & Geyer, 2005). This may be explained by the two-fold effect of novelty. Novelty can lead to positive qualities of experience by fostering curiosity (Lewalter & Geyer, 2009) and thereby support successful learning processes. On the other hand, if novelty is experienced while structure and orientation are not satisfactory, this may overwhelm students due to the disorientation, resulting in low perceived competence. In turn, students’ motivation may suffer (Deci & Ryan, 2002).

In the current study, these issues are addressed through the provision of structure to support students’ perception of competence. Structure can be viewed as a continuum ranging from no structure, which is chaos, to a high degree of structure (Jang, Reeve, & Deci, 2010; Skinner & Belmont, 1993). Jang et al. (2010) categorize three types of instructional behavior: Teachers provide structure by (I) presenting clear, understandable, explicit, and detailed directions to establish expectations with regard to students’ behavior during activities; (II) offering a program of action to guide students’ ongoing activity by initiating and scaffolding the activity, as well as maintaining effort to complete tasks and learning objectives; (III) offering constructive feedback on how students can gain control over valued outcomes, helping students evaluate their skills and supporting their sense of competence (cf. Brophy, 1986; Brophy, 2006; Jang et al., 2010; Skinner et al., 2008; Skinner & Belmont, 1993; Skinner, Zimmer-Gembeck, Connell, Eccles, & Worrell, 1998; Taylor & Wentworth, 2007). Providing structure offers the possibility for students to develop a sense of perceived control over the outcomes of the visit, even if the setting is novel or if preparation was suboptimal. This then might lead to an internal locus of control and prevent feelings of helplessness (Skinner, 1997; Skinner et al., 2008). Teachers can use these provisions of structure to focus on the tasks at hand and actively choose tasks that are well suited to their abilities (Ryan & Deci, 2002). Students may in turn perceive a sense of self-confidence and feelings of effectiveness in their actions (Ryan & Deci, 2002) when they obtain the knowledge of how to achieve expected outcomes (Deci, Vallerand, Pelletier, & Ryan, 1991). Working on tasks that correspond to an individual’s abilities can satisfy the basic need for competence (Skinner, 1996; Skinner et al., 2008) and in turn might contribute positively to intrinsic motivation (Ryan & Deci, 2002).

Several areas can be focused to offer orientation via structure in a physical form, e.g., in the form of workbooks (Basten et al., 2014; DeWit & Sunktasiek, 2008), adequate preparation for novel learning settings (Griffith, 1998), or spatial orientation (Hinc, 2000). These areas can be assigned to the factors advance organizers and orientation and design of the exhibition of the OMoLS physical context (Falk & Dierking, 2000; Falk & Sunktasiek, 2003).

In our study, we focused on presenting clear directions to establish expectations and offering a program of action to guide activities for the distinction of supplementary structure. At the same time, the basic structure still needed to reflect a well-prepared exhibition as invited teachers provided the time of their regular biology courses in school for the visit.

3. Hypothesis (study 1)

As established above, structure can be ascribed to the need for competence (Basten et al., 2014; Grolnik & Ryan, 1989). The provision of structure might reduce disorientation during school visits to an unfamiliar, non-formal learning setting (Connell & Wellborn, 1987; Skinner et al., 2008). This might enable students to experience competent and meaningful interactions with their surroundings and may lead to positive qualities of motivation. Different degrees of structure can be provided in non-formal learning settings. We refer to two levels of structure, namely basic and supplementary structure. We assume that basic structure might not be sufficient to support students’ need for competence, whereas supplementary structure might support students’ perception of competence adequately. Since the perception of competence is a prerequisite for the experience of positive qualities of motivation, supplementary structure is assumed to foster positive qualities of motivation as well.

III. Supplementary structure offered in a non-formal learning setting improves students’ intrinsic motivation in comparison to basic structure.

4. Method (study 1)

4.1. Sample

In our study, 198 students (Mage = 12.07, SDage = 1.12, Mage = 4.97, 44.4% female) from two types of medium level secondary schools (Gesamtschule and Realschule) took part. The percentage of foreign citizens in the regions of the participating schools is 12.7%. Participating students were from grades 5, 6 and 7. School classes were invited to visit the exhibition. Participating classes were randomly assigned to the treatment with basic structure (n = 65) or to the treatment with supplementary structure (n = 133). The pretext took place in the students’ regular biology lessons before the intervention. A nearly equal number of students for each treatment attended this pretext. Regarding the participating students in the first study, one class could not attend the pretext due to time constraints and an important school event. Additionally, individual students were not visiting the exhibition at all due to illness. This resulted in 45 missing values for the test instruments in the pretext. These students could not be included in our analysis.
5. Manuskripte

5.1 Manuskript I: Studies on the effects of structure in the context of an autonomy-supportive or a controlling teacher behaviour on students’ intrinsic motivation

4.2. Test instruments

To control the implementation of structure, we administered an adapted and expanded version of the structure dimension of the Teacher as a Social Context Questionnaire (TASCO; Redman, Skinner, Wellborn, & Connell, 1990). As the physical context of the Contextual Model of Learning is not represented by these scales, items of the subscale help/support as well as the subscale expectation were adapted assessing the perception of structure provided by the teacher. While adapting these items, we considered the two aspects design of the exhibition as well as advance organizers and orientation aids of the CMol’s physical context. These 8 items (Cronbach’s α = 0.76) were used in the posttest and carried out directly after visiting the exhibition. For example, students had to rate the items: ‘following the (welcome) presentation, I knew exactly what to expect.’ Students’ motivation was assessed by an adapted version of the Intrinsic Motivation Inventory (IMI; Ryan, 1982). We used the subscales interest/enjoyment (7 items, Cronbach’s α = 0.82), perceived choice (5 items, Cronbach’s α = 0.61) and perceived competence (6 items, Cronbach’s α = 0.75). All questionnaires used a five-point rating scale ranging from 0 (not at all true) to 4 (very true).

4.3. Study design and operationalization

All students visited a temporary exhibition at the university for a period of 4h. They participated in a hands-on exhibition located in three rooms, each thematically focused on the locomotion systems of humans and animals. They worked in groups of three to four students on up to six workstations per room. The exhibition featured different animals, highlighting the locomotion of swimming, sliding, flying and walking of bi-, quad- and hexapedal. Walking and keeping balance as a bipedal human was examined. Three female and two male teacher trainees conducted the treatments. Teacher trainees worked in groups of three on each given day of the exhibition with one teacher trainee in each room. Each teacher trainee combination was deployed in both treatments. We decided to use teacher trainees instead of the students’ regular biology teachers on purpose. The students were not familiar with the teacher trainees and did not expect any particular behavior from them. The regular teachers’ behavior in the class setting has already developed and the types of teacher behavior may vary between the regular teachers. In contrast, teacher trainees are still flexible in their teacher behavior (de Bijl, van der Zijpt, Dochy, & van den Vleuten, 2012; Tessler, Saramat, & Nivonman, 2010). For the implementation of both levels of structure, the teaching style and the handling of the animals and exhibits was practiced during several meetings prior to the intervention. Teacher trainees got to know the CMol during the first session. The physical context was notably intertwined with the basic need for competence to achieve an understanding of the provisions of structure in the contexts of both the CMol and the SDE. The working materials and the exhibition were designed together with the teacher trainees. Students in the control group were provided with basic structure whereas students in the experimental group were provided with supplementary structure (Table 1). The components of the provision of supplementary structure were derived from two dimensions of the physical context: advance organizers and orientation aids, including clear communication of expectations, and the design of the exhibition (Falk & Mierkowicz, 2005; Falk & Storksdieck, 2003). The components targeted the following types of instructional behavior: (1) presenting clear, understandable, explicit, and detailed directions to establish expectations with regard to students’ behavior during activities; (2) offering a program of action to guide students’ ongoing activity by initiating and scaffolding, as well as maintaining an effort to complete tasks and learning objectives. Supplementary structure was provided to support all the requirements of the physical context since the visit to the exhibition would presumably be the students’ first visit to the university. To ensure that all students would be able to use the learning materials, they were identical in content for both treatment groups. The basic level of structure was already quite structured. Students were not offered a chaotic situation. Instead, basic structure contained basic worksheets and a short explanation of the working materials. Expectations for the students were not explicitly stated, there were no orientation aids between the three rooms and the overall design was not explicitly explained. There were no guidance systems in form of organizers, plates or signs at the exhibits. As such, the overall design only consisted of the exhibits in the rooms.

During typical museum visits, teachers tend to use aims and methods from formal teaching and transfer them to non-formal settings (Griffin, 1994). The instructions and methods used in this study misused this teacher behavior. This behavior can be attributed to the CMol’s personal context. The teacher trainees in our exhibition were task-oriented, moved actively about the room, looked over students’ shoulders from time to time and assigned workstations and exhibits to the students (cf. Griffin, 1994; Griffin & Symington, 1997). They used directives and direct instructions like the teachers in school (Pelletier & Sharp, 2009) to make sure that students were engaged in the contents as intended. In addition, the teacher trainees in our exhibition sometimes asked students what they were doing or reminded them of the time constraints. To account for teachers’ emphasis on cognitive achievement in extracurricular settings (Leventhal & Geyer, 2009), they emphasized the importance of the students’ work in relation to their biology classes and potential written examinations.

4.4. Statistics

To check the implementation of basic and supplementary structure, an ANCOVA was calculated. The subscales of the Intrinsic Motivation Inventory were compared using MANCOVA. The type of school was used as a covariate in each of the analyses.

5. Results (study 1)

In study 1, we were interested in the effects of basic and supplementary structure on students’ motivation during a visit to a non-formal learning setting. Preliminarily, the effects of structure and supplementary structure need to be reported to ensure successful operationalization. ANCOVA revealed a significant effect for structure with a medium effect size (FU,204) = 15.251, p < .001, $\eta^2 = 0.070$. The type of school had no effect (FU,204) = 0.733, p = .393. The provision of supplementary structure was perceived as being more structured than the provision of basic structure. As for the results regarding students’ intrinsic motivation, the provision of supplementary structure showed no effect in any subscale of the Intrinsic Motivation Inventory (Table 2).
5. Manuskripte

5.1 Manuskript I: Studies on the effects of structure in the context of an autonomy-supportive or a controlling teacher behaviour on students’ intrinsic motivation

Table 2

<table>
<thead>
<tr>
<th>Subscale</th>
<th>M (± SD)</th>
<th>Type of school (Autonome)</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest/enjoyment</td>
<td>2.34 (± 0.88)</td>
<td>R(1,190) = 2.483</td>
<td>p = .117</td>
</tr>
<tr>
<td></td>
<td>2.39 (± 0.76)</td>
<td>R(1,195) = 0.825</td>
<td>p = .385</td>
</tr>
<tr>
<td>Perceived choice</td>
<td>2.00 (± 0.40)</td>
<td>R(1,194) = 5.487</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td></td>
<td>2.00 (± 0.66)</td>
<td>R(1,194) = 0.871</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>2.29 (± 0.77)</td>
<td>R(1,195) = 0.086</td>
<td>p &lt; .05</td>
</tr>
<tr>
<td></td>
<td>2.40 (± 0.74)</td>
<td>R(1,195) = 0.293</td>
<td>p &lt; .05</td>
</tr>
</tbody>
</table>

Supplementary structure did not lead to higher interest and enjoyment, higher competence or a higher perception of choice while students worked on the task. Contrary to our hypothesis, supplementary structure did not facilitate higher intrinsic qualities of motivation in comparison to basic structure. Effects of the control-oriented type of school were found only in the subscale perceived choice with a small effect size. Distinct types of schools might provide choice differently.

6. Discussion (study 1)

The aim of this study was to assess the effects of basic and supplementary structure on students’ intrinsic motivation during an exhibition at a university. We assumed that the provision of supplementary structure leads to higher intrinsic motivation than the provision of basic structure. These assumptions cannot be supported with the results of study 1. We found no differences in any subscale of the Intrinsic Motivation Inventory in the comparison of both treatments. These results might indicate that the implementation of structure was not successful. If there are no differences in the students’ perception of structure in the comparison of both treatments, it wouldn’t be surprising that there are no differences in the positive predictors of students’ intrinsic motivation as well. Nevertheless, the results of the implementation of structure reveal differences in the students’ perception between the treatment with basic structure and the treatment with supplementary structure that show a medium effect size. With a medium effect size for the operationalization of structure, we may not expect major differences in students’ intrinsic motivation between basic and supplementary structure. However, the findings showed no effects in any of the subscales of the Intrinsic Motivation Inventory between both treatments. Therefore, we assume that the operationalization of structure is unlikely to be the main reason for the lack of differences in the Intrinsic Motivation Inventory between the treatment with basic structure and the treatment with supplementary structure.

Study 1 was conducted to reproduce a typical school class visit to a non-formal setting. Included in the design of this situation is the teacher behavior. Described in the research of Griffin and colleagues (Griffin, 1994; Griffin & Syzmung, 1997) as well as Pelletier and Sharp (2009), typical teacher behavior is marked by a transfer of methods from formal to non-formal settings, task-orientation, directives and direct instruction (Griffin & Syzmung, 1997). Dillon et al. (2006) mention teacher-related factors that have an influence on learning in extracurricular settings and students’ quality of experience. These include fear and concern for students’ health and safety, lack of confidence in extracurricular activities, curriculum emphasis and a shortage of time and resources. Teachers visiting non-formal settings are often stressed, are worried about losing track of students and are afraid that they cannot answer all student questions (Griffin & Syzmung, 1997). This may result in stressful situations for the teachers and tension may arise in the teacher. As teachers have only limited influence over the content students engage in (Barnett, Lucas, & Dooley, 1996; Griffin, 1998), they tend to use task-oriented instructions (Griffin & Syzmung, 1997) to make sure students move and interact with the exhibits as the teacher expects them to. Griffin and Syzmung (1997) further report that teachers put great emphasis on cognitive teaching goals in non-formal settings. Students may be stressed in non-formal settings as well. They may experience directive teacher behavior and found only in the subscale perceived choice with a small effect size. Distinct types of schools might provide choice differently.

In summary, the observations from learning situations in non-formal settings show that students and teachers may feel stressed. Consequently, each interaction between students and teachers might be affected by the concerns and stress teachers and students are exposed to. From the teachers’ perspective, this might justify controlling classroom methods to ensure students’ reach their learning achievements. The question remains whether the overall picture shown above is suitable teacher behavior for a beneficial museum experience in non-formal settings. Not all elements of the implemented structure can be assumed to be autonomy-supportive. It is possible and potentially problematic that the perception of additional explanations, mini-guidances and timetables were not perceived as structuring but controlling. These elements might have been perceived as constraints on the free choice environment that non-formal settings offer. The students’ perception of the teacher behavior may be seen in the results of the Intrinsic Motivation Inventory subscale perceived choice. This subscale can provide indications of the influence of controlling teacher behavior on students’ perception of choice during the exhibition. Values of 2.00 (± 0.66) for basic structure and 2.00 (± 0.66) for supplementary structure, respectively, show a moderate perception of choice. Overall, the teacher behavior was not perceived as very controlling as one might have suspected. As students may be used to controlling teacher behavior both in and out of school settings, the control might not be perceived as such (cf. Martinek, 2010).

Structure as instructional style can be conveyed in multiple ways, e.g. in autonomy-supportive or controlling manners. This could be shown for different elements of provisions of structure, namely rules, communication, aims, expectations, rewards and feedback (Deel, Kasmør, & Ryan, 1999; Kasmør, Ryan, Berner, & Holt, 1984; Ryan, Mims, & Kooijman, 1992; Schul, 2004). Jang et al. (2015) showed that both instructional styles are independent and complementary in the sense that they each provide a unique contribution to the prediction of students’ engagement and they are positively correlated. Siersens, Vansteenkiste, Goossens, Soenens, and Dochy (2009) showed that structure only has a positive impact on students’ engagement. This could be offered in a moderate or high autonomy-supportive manner (cf. Jang et al., 2015; Vansteenkiste et al., 2013). Low autonomy or rather controlling teacher behavior diminished these effects of structure (Siersens et al., 2009). Assuming that structure and autonomy support are in an independent relation, they may be supported in varying degrees. Studies have shown that the introduction of structural elements, e.g. to
orient a class towards a specific goal, does not contradict autonomy support (Jang et al., 2010; Ryan, Connell, & Deci, 1985). Autonomy support should enable students to adapt their behavior to their personal goals and values (Cozniel & Wellborn, 1991), yet students can only decide whether learning requirements do fit their needs when expectations are transparent. Autonomy-supportive teacher behavior can also potentially have an influence on the students' perceptions of relatedness. Acknowledging negative feelings, being empathetic, valuing students' ideas and opinions and appreciating their work are important aspects in fostering students' autonomy (Boeraen et al., 2015; Reeve, 2002; Su & Reeve, 2011), but can also be seen as involvement, which influences the students' relatedness. In this context, the relationship between teacher and student may be the key to influencing students' quality of motivation positively. If the students perceive a low relatedness in their relationship to their teacher, autonomy-supportive and competence-supportive aspects may not be fruitful.

Taking these considerations into account, not only the students' perception of competence should be focused, but their need for autonomy as well. Hence, the described teacher behavior in non-formal settings must be analyzed more closely, focusing on the need for autonomy. In study 2, the physical and personal contexts were represented by the facilitation of competence through structure, as well as autonomy through autonomy-supportive teacher behavior. The need for autonomy is accompanied by the need for self-determination. To feel in control of the environment, a student must perceive himself as the causal agent of an action (Krapp, 1999; Ryan & Connell, 1989). Teacher behavior can have an impact on students' perception of autonomy, especially on the qualities of autonomy, namely choice, volition and locus of causality (cf. Reeve, Nix, & Hamms, 2003). Choice is essentially a self-determined selection among different options (Reeve, 2002), which needs to be meaningful to foster perceptions of autonomy (Meyer-Abens & Wilde, 2013; Katz & Assor, 2007; Reeve et al., 2003).

A feeling of volition can arise if actions are undertaken and accomplished without external strain (Reeve, 2002). The locus of causality describes the origin of the initiation and execution of actions as external or internal (Reeve et al., 2003). If the person experiences their own self as the origin, actions are perceived as self-regulated (deCharms, 1968; Reeve et al., 2003) and the locus of causality is perceived as internal. It is defined as external if the origin of initiation is heteronomous (Reeve et al., 2003). There are many aspects of autonomy support. Jang et al. (2010) describe three categories. Instructional behaviors need to nurture inner motivational resources, rely on non-controlling language, and acknowledge the students' perspective, ideas and feelings (cf. Reeve & Beex, 2014; Su & Reeve, 2011). Teacher behavior summed up in these categories is comprised of: acknowledging and valuing student's ideas, feelings and perspectives; being empathetic and respectful; identifying and nurturing the students' needs, interests, and preferences; providing rationales for learning activities and assignments; providing optimal challenges and highlighting meaningful teaching goals or features of the tasks (Froiland & Davison, 2014; Froiland, Davison, & Worrell, 2017; Haeren et al., 2015; Jang et al., 2015; Reeve, 2002; Reeve, Bolt, & Cui, 1999; Reeve & Cheon, 2014; Su & Reeve, 2011).

The described teacher behavior that is normally found in non-formal settings, even if unintended, might interfere with self-determined working and learning experiences by impairing feelings of volition, choice and possibly fostering an external locus of causality (Griffith, 1994, 1998). In study 1, teachers did not explicitly offer freedom of choice as they determined how to obtain results and scheduled which exhibits students had to work with. This situation might have inhibited students' perception of choice. The teacher's instructions were task-oriented, and they used directives. This behavior could have been perceived as controlling, pressuring and external in nature and may have fostered an external locus of causality. Experiencing such external strain, e.g. pressure to behave in a specific way, as well as the experience of having no choice and being assigned to work on a specific exhibit, might have led to less feelings of volition. Without intending to, the behavior shown by the teachers in our exhibition may have undermined students' autonomy.

Extracurricular settings can foster visitors' interest and fascination (Gäldyson, 2001), facilitate authentic encounters (Griffith, 1998) and may offer the freedom of choice due to their range of possibilities (Ramberger & Tal, 2006). In fact, extracurricular settings might be especially appropriate for autonomous and intrinsically motivated learning. The only constraint seems to be the students' perception of autonomy, which must not be impaired. The teacher behavior described above in non-formal settings could be contradictory to intrinsically motivated learning in extracurricular settings. Autonomy-supportive teacher behavior might be a valuable tool for enabling meaningful museum learning. Supporting students' need for autonomy may be a prerequisite to fostering students' need for competence, and to facilitating intrinsic motivation (Deci & Ryan, 2000; Jang et al., 2015; Skinner et al., 2008).

In the picture established from the data of study 1, teaching in a typical manner in non-formal settings, i.e. rather controlling, might not have been conducive to fostering intrinsic motivation. Supporting a regular school class visit to a museum or non-formal setting with provisions of supplementary structure is insufficient in supporting students' motivation. It may actually have been the case that the provided structure was mistaken for control. Consequently, we conducted a second study that investigated the effects of providing two levels of structure again. This time, we put special emphasis on implementing both levels of structure in an autonomy-supportive way.

7. Hypothesis (study 2)

In study 2, we maintained our hypothesis from study 1.

H2. In an autonomy-supportive situation, supplementary structure offered in a non-formal learning setting improves students' intrinsic motivation in comparison to basic structure.

8. Method (study 2)

8.1. Sample

189 German students (M_age = 12.44, SD_age = 1.10, M_score = 4.69, 50.9% female) from two types of middle secondary schools (Gymnasiums and Real schools) took part in the second study. The percentage of foreign citizens in the regions of the participating schools is 12.7%. Participating students were from grades 5, 6 and 7. Participating classes were randomly assigned to the treatment with basic structure (n = 89) or to the treatment with supplementary structure (n = 100).

8.2. Test instruments

The same test instruments were administered. To control the implementation of structure, the adapted version of the TASKQ mentioned in study 1 (8 items, Cronbach’s α = 0.77) was used. To test the implementation of autonomy support, we used an adapted version of the Basic Psychological Need Scale - Autonomy (BPNS-A; Band, Deci, & Ryan, 2004). The scale (3 items, Cronbach’s α = 0.80) was used in the posttest. Again, the students' quality of motivation was assessed with the adapted Intrinsic Motivation Inventory subscales interest/enjoyment (7 items, Cronbach’s α = 0.80), perceived choice (5 items, Cronbach’s α = 0.65) and perceived competence (6 items, Cronbach’s α = 0.76).

8.3. Study design and operationalization

The implementation of basic and supplementary structure was identical to study 1 (Table 1). In contrast to the first study, the teacher
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trainees instructed students using autonomy-supportive teacher behavior. Aspects of autonomy-supportive teacher behavior were discussed and practiced over the course of several meetings prior to the intervention. In the first meeting, participants had to assign statements to an autonomy-supportive or a controlling situation. Starting from their understanding of both concepts, self-determination theory, particularly the basic need for autonomy, was taught and discussed. This included the three qualities of autonomy (willingness, locus of causality and choice). In this context, the aspects that had to be implemented in the intervention were discussed and linked to these qualities. The third and fourth meeting consisted of practical assignments in which participants had to enact autonomy-supportively in different situations. In this context, the teacher trainees conducted roleplays by way of example. As a result, teachers interfered with students’ activities only when requested or if necessary, e.g. for security reasons. Questions students were asking or problems they were having were always treated seriously to give value to students’ ideas and opinions. Teachers communicated using the words “can” or “may”, and offered choices among workstations to meet the prerequisites of perceived autonomy, choice and volition. The implementation of this non-controlling language offers flexibility and minimizes pressure. This behavior may have enabled the students to explore more freely, and actively decide which exhibit they perceived as most interesting and at which exhibit they preferred to work. Perceiving a choice and the feeling of acting voluntarily may also foster an internal locus of causality. There was no task announcement or any reminder of time constraints in order to avoid accentuating external strains. External strains may foster the perception of an external locus of causality. The components are further assumed to affect each other positively as the three qualities of autonomy are interdependent (Reeve et al., 2003). As described above, an additional aspect was to support students’ autonomy. In this study, we focused on two of the three categories stated by Jang et al. (2010), namely: relying on non-controlling informational language and acknowledging students’ perspectives, ideas, and feelings.

8.4. Statistics

Again, an ANCOVA was used to investigate possible differences in the students’ perception of structure. An ANOVA was used to assess the implementation control for autonomy. By using MANCOVA, the students’ intrinsic motivation was compared in both treatments. The covariate was the type of school.

9. Results (study 2)

In the second study, we again investigated the effects of two degrees of structure on students’ motivation. Teachers used autonomy-supportive teacher behavior and again provided either basic or supplementary structure. The preliminary analysis of the TASQ showed a significant main effect for structure (F(1,181) = 8.216, p < .001, η² = 0.044). Students’ type of school as covariate had no effect (F(1,181) = 3.120, p = .079). As the provision of supplementary structure was perceived as being more structured than the provision of basic structure, the implementation of different degrees of structure was regarded as successful. The effect for our implementation of basic and supplementary structure is comparable to the effect in our first study. The preliminary analysis of the BFNS-A showed no significant effect for structure between the treatments with supplementary and basic structure (F(1,188) = 2.119, p = .147). Presumably, students perceived the behavior of the teacher trainees in both treatments as equally autonomy-supportive. Furthermore, we were again interested in students’ intrinsic motivation. The results from the Intrinsic Motivation Inventory showed significant effects for the provision of supplementary structure in all subscales (Table 3). Students provided with supplementary structure perceived more interest and enjoyment while working on the tasks and presumably perceived the offered choices. They also perceived themselves as more competent while working on the workstations and worksheets. Table 3 shows that students’ type of school had no effect on any of the measured predictors of intrinsic motivation. The affiliation to a particular type of school had no influence on students’ quality of motivation.

Comparing the results of study 2 to the results of study 1, major differences are found. In both studies, structure was varied identically, while the teacher behavior in study 2 was explicitly autonomy-supportive. The self-report measure of intrinsic motivation that is interest/enjoyment, as well as the positive predictors perceived choice and perceived competence, showed higher means for supplementary structure in comparison to basic structure in study 2, but not in study 1. Presumably, the teacher behavior had an influence on the impact of supplementary structure.

10. General discussion

In our studies, we were interested in the effects of two different degrees of structure, basic and supplementary, on students’ intrinsic motivation during a school class visit to an extracurricular setting. We assumed that supplementary structure in the form of communicating clear expectations towards students, offering guidance systems, advance organizers and orientation aides could reduce disorientation and counteract the high demands of extracurricular settings, resulting in higher perceived competence and motivation.

In study 1, we reproduced a situation comparable to a regular school class visit to a non-formal setting using known forms of typical teacher behavior. Our assumption regarding students’ perception of competence and their intrinsic motivation cannot be supported in this study. No differences were found in the subscales of the Intrinsic Motivation Inventory in the comparison of both treatments. As the effects of the implementation are apparent, the absent effects on the Intrinsic Motivation Inventory may be linked to another factor. We then presumed that the teacher behavior in study 1 may have been an obstacle in fostering positive qualities of motivation. The usual teacher behavior seen in extracurricular settings is characterized by the tension often projected by teachers and at the same time by task-orientation and direct instructions. The implemented teacher behavior in study 1 mirrored this situation. This behavior might have influenced the students’ perception of the qualities of autonomy, namely choice, volition and locus of causality (cf. Reeve et al., 2003). Therefore, it could have been ineffective in fostering students’ perception of competence and intrinsic motivation. The assumed beneficial effects of the provision of supplementary structure on students’ perception of competence and their intrinsic motivation seem to be undermined by this teacher behavior. In this case, structure itself may have been perceived not as helpful, but rather as overbearing and somewhat controlling instructional support (Jang et al., 2003). Consequently, positive effects on students’ motivation cannot be found.

As study 2 has shown, if supplementary structure is provided in an autonomy-supportive way, it can affect students’ motivation positively. The provision of supplementary structure is assumed to act as a support for students while working with the materials and exercises. At the same time, offering additional structure might help students actively engage in their surroundings, and feelings of disorientation and demand caused by the novelty of the setting might then be counteracted. The effect of supplementary structure is accompanied with higher perception of interest and enjoyment in the tasks, and higher perceived competence. Most interesting is the positive effect of provided supplementary structure on the students’ perception of choice. Choices regarding working materials and workstations can be realized, compared to one another correctly and may be perceived as more valuable. Only then may choices be perceived as meaningful (Kelley, 1979; Williams, 1996). Offering supplementary structure in an autonomy-supportive manner does not seem to be perceived as control. The results suggest that instructional styles, autonomy support and supplementary structure are
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5.1 Manuskript I: Studies on the effects of structure in the context of an autonomy-supportive or a controlling teacher behaviour on students’ intrinsic motivation

Table 3

<table>
<thead>
<tr>
<th></th>
<th>M (± SD)</th>
<th>M (± SD)</th>
<th>Type of school (covariate)</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest/enjoyment</td>
<td>2.25 (± 0.63)</td>
<td>2.76 (± 0.76)</td>
<td>P1 (1,186) = 1.620, p = .205</td>
<td>P1,186 = 12.565, p &lt; .001, χ² = 0.063</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>2.43 (± 0.54)</td>
<td>2.69 (± 0.73)</td>
<td>P1 (1,186) = 1.642, p = .204</td>
<td>P1,187 = 7.856, p &lt; .05, χ² = 0.040</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>2.52 (± 0.63)</td>
<td>2.79 (± 0.79)</td>
<td>P1 (1,185) = 3.560</td>
<td>P1,185 = 5.416, p &lt; .05, χ² = 0.028</td>
</tr>
</tbody>
</table>

It should be taken into account that the effects in the comparison of basic and supplementary structure on the students’ perception are only medium effects. As the intervention effects on students’ intrinsic motivation are downstream in the perception of structure, major differences were not to be expected. Students were not offered a chaotic situation in which they felt overwhelmed and experienced disorientation in the treatment with basic structure, as this treatment was already quite structured. Consequently, the medium effect in the comparison of both treatments is not surprising.

The assumed positive effects of structure on students’ quality of motivation that the OMAD and the SDT predict could only be found when the supplementary structure was provided in an autonomy-supportive way. Supporting students’ need for autonomy may be a prerequisite in satisfying students’ need for competence, and therefore fostering their intrinsic motivation. Providing structure in a non-formal setting in a controlling manner proved ineffective in fostering students’ intrinsic motivation.

Limitations

In this paragraph, potential limitations of both studies are discussed. First, the operationalizations of structure and autonomy support are reviewed. A short discussion of the possible impact of students’ relatedness to the teacher on the provision of structure follows. In addition, differences in the behavior of the students’ regular biology teacher and the teacher trainer are mentioned as possible interfering factors.

The operationalizations of structure as well as autonomy do not cover all aspects mentioned in the review of the literature, e.g., feedback has not been implemented in this study. According to Jang et al. (2010), feedback may have an influence on the perception of competence. It might be that the provision of additional aspects of structure would have influenced the students’ intrinsic motivation even more. A further aspect may be found in the treatment with supplementary structure itself. Supplementary structure might have been perceived as redundant information and may have been given to children who did not need it. This could have undermined the students’ perception of competence instead of supporting it. This seems unlikely, since the additional provision of structure was not mandatory for the students. At first, the students in both treatments were welcomed and received information about the rooms and exhibits. Afterwards, the students in the treatment with supplementary structure had the chance to read the information about the exhibits and rooms again. Students could use the structural provision, but they were not obligated to do so. As such, students in need of support were encouraged to use it, while those who had no need were not forced to do so. We believe that no redundant information was provided, or at least that it was not perceived as redundant in the most students, as the setting and the exhibits were new to all of them. As such, the novelty of the setting affected all students and the provided information in the treatment with supplementary structure offered a chance to advice students even when they did not understand the initial information.

As the teacher trainees were unknown to the students, working in this unfamiliar situation might have had an impact on their perceptions of structure and competence. The provision of structure and the instructions may have differed in comparison to the students’ regular biology teachers. This might have influenced the students’ perception of structure and autonomy.

Looking at the three categories of autonomy-supportive teacher behaviors (using non-controlling language, acknowledging students’ perspectives, ideas and feelings and nurturing inner motivational resources), the operationalization implemented in this study mainly addressed the first two categories. Teacher trainees did not know students prior to the intervention. Therefore, they did not exactly know the students’ needs, interests, and preferences as well as their prior knowledge of the contents of the exhibition and their competencies regarding biological methods and applicable knowledge. As the rooms offered plenty of choices, e.g. which exhibits students wanted to work with or who they wanted to work with, students’ preferences and interests could only be taken into account to a limited extent. In addition, it was not possible to nurture given interests and preferences for every student in the given timeframe of 4 h. Nevertheless, a rationale was provided that related the content of the exhibition to the students’ own body and was assumed to design the content as personally meaningful (cf. Sa & Reeve, 2011). This might have fostered students’ interest (cf. Mitchell, 1993). Taking all three basic needs anchored in the SDT into account, the students’ relatedness towards their teacher plays an important role in their quality of motivation (cf. Reeve, 2002). A low perception of relatedness in the students’ relationship to their teacher may negatively influence the perception of autonomy-supportive and competence-supportive aspects offered by the teacher. In study 2, the students’ perception of relatedness might have been higher than in study 1, as some of the implemented autonomy-supportive aspects, such as acknowledging students’ ideas, opinions and perspective, can also be assumed to be relatedness-supportive (cf. Reeve, 2002). Nevertheless, a possible influence of relatedness as an interfering factor is unlikely to be a reason for systematic errors in our studies, since students were treated equally in terms of relatedness in both compared treatments in study 1.
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as well as in both compared treatments in study 2.

Future research

Since the relationship between perceived structure, perceived competence and students’ intrinsic motivation does not seem to be as simple as initially assumed, further research needs to be conducted.

In future studies, other methods of supporting students’ perception of competence as well as specific aspects of structure may be investigated. Offering feedback as a source of structure could be addressed (cf. Jing et al., 2010). For the methods in the study, the question remains of how students’ intrinsic motivation is influenced by specific implemented aspects, and by which aspects positive qualities of motivation can be fostered in particular. In both studies, various aspects of providing structure were considered. The implementation of these aspects achieved a medium effect size in the comparison of perceived structure in both treatments. The investigation of specific aspects of structure might lead to even smaller effects. A replication of the studies presented here in a 2 x 2 design would allow a further direct comparison of autonomy-supportive and controlling teacher behaviors and their interactions with different amounts of structure.

Nevertheless, we believe that both studies contribute to the understanding of the relevance of structure and the importance of autonomy-supportive teacher behavior in the context of providing structure. These findings are in line with previous research (cf. Jing et al., 2010; Siemens et al., 2009). A unique aspect of our study is the link between Self-Determination Theory and the Conceptual Model of Learning, an important theory in the context of non-formal learning. We discussed how the implementation of structure by the physical context of the Contextual Model of Learning may be applied. Our results provide insight into students’ perception of structure in out-of-school settings, comparing a situation that is typical for school visits to out-of-school settings in study 1 and a situation with autonomy-supportive teacher behavior in study 2. Furthermore, our first study indicates that the observed controlling teacher behavior in non-formal settings may have a negative impact on students’ perception of structure, and therefore on students’ motivation. In this case, the opportunity for self-determined and successful learning offered by non-formal settings might be lost. With our research, important aspects for motivating teacher behavior in non-formal settings may have been revealed. These results could help support teachers in non-formal settings in terms of providing structure.

Funding information

The author Nadine Großmann is funded by the German Federal Ministry of Education and Research (funding code: 01JA1605).

Acknowledgements

This project is part of the “Qualitätssoffensive Lehrerbildung”, a joint initiative of the Federal Government and the Länder which aims to improve the quality of teacher training. The programme is funded by the Federal Ministry of Education and Research (funding code: 01JA1608). The authors are responsible for the content of this publication.

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5.1 Manuskript I: Studies on the effects of structure in the context of an autonomy-supportive or a controlling teacher behaviour on students’ intrinsic motivation


5.2 Manuskript II: Motivational effects of structure and autonomy support in non-formal learning

Zeitschrift: *Electronic Proceedings of the 11th Conference of European Researchers in Didactics of Biology* (Im Druck)

MOTIVATIONAL EFFECTS OF STRUCTURE AND AUTONOMY SUPPORT IN NON-FORMAL LEARNING

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**Keywords:** autonomy support, structure, motivation, non-formal learning environment, Self-Determination Theory

**Abstract**

Non-formal settings offer opportunities for self-determined learning. However, these learning settings often lack structure. Teachers accompanying their students in non-formal settings tend to use restrictive and controlling behavior. Provisions of structure and autonomy-supportive instructions are regarded as beneficial for supporting intrinsic motivation. The aim of our study was to investigate the motivational effects of two types of teacher behavior, autonomy-supportive vs. controlling, and of two levels of structure, extensive vs. basic. The sample consisted of 114 students (age: 11.37±0.59 years) from German schools of higher types of tracking. They visited an exhibition at the university for four hours. We measured intrinsic motivation in a post-test using an adapted version of the Intrinsic Motivation Inventory with the subscales *interest / enjoyment, pressure / tension, perceived choice* and *perceived competence*. In accordance with the theory, results showed significant main effects of teacher behavior on *perceived choice*. For structure, the significant main effect of *perceived choice* was contrary to the theoretical expectations. However, significant interaction effects for all subscales have been found. The combination of controlling teacher behavior and extensive structure seemed to be least supportive for students’ intrinsic motivation.
1. Introduction

Visits to non-formal settings, such as museums, can offer multifaceted learning environments and foster exploration. At the same time, these field trips are often affected by the “novel field trip phenomenon” (Falk, Martin, & Balling, 1978). Students perceiving high levels of novelty may be disoriented and concentrate on non-relevant aspects of their surroundings (Falk & Balling, 1982). Furthermore, non-formal settings may be unstructured and provide an overabundance of choice. This could introduce demands for students that might lead to disorientation and missed learning opportunities (Falk & Balling, 1982; Gottfried, 1980; Griffin & Symington, 1997). In this context, it is hardly surprising that learning achievements during visits to non-formal settings reach a medium level at best (Koran, Koran, & Ellis, 1989). When investigating learning in non-formal settings, research proves ambiguous (Borun & Flexer, 1983; Griffin, 2004; Lewalter & Geyer, 2005). Rennie and McClafferty (1995) argue that this mixed picture arises from the visits’ framework, the embeddedness of the visit in school lessons, the presentation of the visit and, in particular, the novelty of the setting. Falk and Dierking’s (2000; 2016) Contextual Model of Learning (CMoL) describes museum learning, i.e. in museums, zoos, interactive exhibitions etc., as a holistic experience concerning the personal, sociocultural and physical contexts. Falk and Dierking (2000) attribute a number of components to each of the contexts. The personal context reflects a person’s expectations, motivation and interests as well as their previous knowledge. The sociocultural context deals with mediation within visitor groups, and between guides and visitors. The physical context is concerned with advance organizers, orientation aides and the overall design of an exhibition (Falk & Storksdieck, 2005), as well as the preparation prior to a visit (Falk & Dierking, 2000; 2016).

Self-Determination Theory (SDT) explains how wellbeing, intrinsic motivation and motivated learning can arise in human beings (Deci & Ryan, 2002). Examining non-formal settings from a SDT-perspective might provide further insights into the learning process. In SDT the basic needs for autonomy, competence and relatedness are regarded as requirements for positive qualities of motivation to arise (Deci & Ryan, 2002). Fulfillment of the basic needs enhances students' intrinsic motivation, their sense of well-being and leads to more engagement (Jang, Reeve, Ryan, & Kim, 2009; Niemiec, Ryan, & Deci, 2010). According to cognitive evaluation theory, one of the sub-theories of SDT, autonomy and competence are the most important prerequisites for intrinsic qualities of motivation to arise (Deci & Ryan, 1980). Autonomy support plays a key role in facilitating task-persistence when no external support is present (Connell & Wellborn, 1991), and can be fostered by autonomy-supportive instructions (Skinner, Furrer, Marchand, & Kindermann, 2008). Autonomy support is characterized by non-controlling language, and giving students room to make decisions concerning their actions, while acknowledging students’ task-related thoughts and perspectives. According to SDT, there are two opposed interpersonal styles, autonomy support and control, which lead to self-determined or to non-self-determined motivation, respectively (Vansteenkiste et al., 2012). The basic need for competence represents the innate tendency to seek new and challenging experiences, and to expand, discover and improve personal skills (Ryan & Deci, 2000). The need for competence is described as interacting meaningfully with one’s surroundings and achieving highly valued goals (Deci, Vallerand, Pelletier, & Ryan, 1991; Ryan & Deci, 2002). This means that opportunities must be provided to practice personal skills and abilities, and to experience physical and psychological confirmation (Ryan & Deci, 2002).

When an out of school visit is viewed from a SDT perspective, teacher behavior and the structure of the non-formal setting should be the particular focus. Concerning teacher behavior, both interpersonal styles described by SDT are found in non-formal settings.
According to Falk and Dierking (2016), educators must be mindful of the needs and goals of the visitors that coincide with their personal context, and which may be, in essence, similar to SDT’s autonomy support. On the other hand, teachers visiting non-formal settings are often tense and afraid of losing students, or worry about being unable to answer students’ questions (Dillon et al., 2006; Griffin & Symington, 1997). This often results in restrictive behavior (Griffin & Symington, 1997), which students could perceive as controlling.

On the other hand, the structure of the non-formal setting and the resulting perceived competence of visitors are of significance. During their first encounter in a non-formal setting, learners might experience disorientation and insecurity, and the new location may be perceived as distracting (Falk & Balling, 1982; Gottfried, 1980; Griffin & Symington, 1997). Providing structure could help learners regulate their own learning process and regain feelings of competence. Structure can be viewed as a two-dimensional continuum, extending from a high degree of structure to a complete absence of structure (Jang, Reeve, & Deci, 2010), the latter of which is referred to as chaos (Jang et al., 2010). Structure can be provided in various ways, e.g., in the form of worksheets (DeWitt & Storksdieck, 2008) and pre-visit preparations (Griffin, 1998). Another form of structure is spatial orientation, which provides students with a conceptual and spatial preview of a new location, e.g., a museum (Hiss, 2000). These provisions of structure may enable learners to maintain their focus and choose specific tasks or challenges that are well-suited to their level of ability (Griffin, 1998; Ryan & Deci, 2002). Thus, structure might support students’ perception of competence (Dupont, Galand, Nils, & Hospel, 2014; Skinner, 1995; Skinner et al., 2008; Vansteenkiste et al., 2012).

2. Research Question

In SDT and in non-formal settings the needs for autonomy and competence are of importance. Autonomy support can fulfill the need for autonomy (Skinner et al., 2008), and provision of structure can fulfill the need for competence (Dupont et al., 2014; Vansteenkiste et al., 2012). This is i.a. possible through developing perceived control and an internal locus of control, which reduces the sense of helplessness (Skinner & Belmont, 1993; Skinner et al., 2008). Hospel and Galand (2016) state that autonomy support and structure could be seen as complementary and mutually supportive dimensions (Jang et al., 2010; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Vansteenkiste et al., 2012). Combining the perspectives of CMoL and SDT, this study varied teacher behavior (autonomy-supportive vs. controlling) and the amount of structure given (extensive vs. basic) in our exhibition, impacting the three contexts as well as the basic needs for autonomy and competence. Teacher behavior presumably influences the components of the sociocultural context, as it directly affects the relationship between teacher and learner. It might be concerned only indirectly with the personal context, as we expect it to affect the learners’ motivation. Structure, on the other hand, directly influences the components of the physical context and, presumably, indirectly influences the personal context as well. The given amount of structure might have an impact on learners’ motivation, too. Consequently, our research question addresses the following main effects and their interactions: How does teacher behavior during the field trip, the structure of the exhibition, and the interaction between teacher behavior and structure influence students’ intrinsic motivation?
3. Methods

The sample consisted of 114 (55% female) students aging 11.37±0.59 years from the highest type of tracking. All students visited an exhibition located in a German university for four hours, and attended a participatory exhibition thematically centered on the locomotor systems of humans and animals. Students worked in groups of three to four children. The exhibition was spread across three rooms, and each room offered up to six workstations. The three teachers in the exhibition (‘guides’) were biology students of advanced semesters.

The autonomy-supportive and controlling teacher behaviors were explained and clarified in great detail, and teachers were trained to behave according to theory, either autonomy-supportive “A” or controlling “C”. The autonomy-supportive teaching style (A) was characterized by specific verbal cues. Teacher-student interactions were governed by certain rules: instructions started with “can” or “may”, and the imperative was not used. Teachers interrupted activities only when requested or necessary due to security reasons. Students were encouraged to explore and work independently. Workstations were not assigned, and no time constraints were given. The controlling teaching style (C) was characterized by teachers actively moving about the room and occasionally looking over students’ shoulders. Their communication was characterized by the use of imperatives and instructions using “must”, “should”, and “have to”. Students were assigned to workstations according to a mandatory plan. Teachers periodically asked students what they were doing, or reminded them of time constraints and the importance of their work in relation to a written examination. In this study, we focused on a particular element of teachers’ instructional style. Teachers were schooled in SDT, the use of the mentioned verbal cues and ways to effectively use these behaviors in practice. When students were asked whether teachers let them decide for themselves how to deal with tasks and workstations and let them distribute their time freely, or whether they felt pressured, they only showed high perceived autonomy when facilitated by autonomy-supportive teachers. As three teachers were active during each school visit, the perceived autonomy was averaged. The internal consistency was Cronbach’s α = .72.

Regarding structure, students received either a basic level of structure “S”, or an extensive amount of structure “S+”. Independent of the treatment, the learning materials were identical regarding content. Basic structure (S) consisted of a brief explanation of the working materials. Students in this treatment used basic worksheets with closed and open-ended questions regarding the exhibition. The extensive structure (S+) comprised all elements of basic structure and contained additional elements. These additional elements were pre-visit preparations, where teachers provided a preview of the day and its contents, as well as clear expectations for students’ work, structure-supportive instructions, and explanations of working materials and their usage via examples taken directly from the worksheets (e.g. Falk & Dierking, 2000). Exhibits were marked by organizers and labels which corresponded to labels in the structured worksheets, operating as orientation aides. Worksheets used the same closed and open-ended questions. The rooms were each marked with an individual animal symbol (mascot) that was found on the corresponding worksheet, and was also used to guide students along pathways between the rooms. At the beginning of each room, students received minimal guidance that lasted three to four minutes to get acquainted with the exhibits. Both treatments were combined, resulting in four treatment conditions: AS and AS+, CS and CS+.

Being interested in the quality of motivation that arises through these treatments, we used an adapted version of the Intrinsic Motivation Inventory (IMI; Ryan, 1982) with a five-point rating scale, ranging from 0 (not at all true) to 4 (very true) in the post-test. The assessed subscales were interest/enjoyment, pressure/tension, perceived choice and perceived competence. The interest/enjoyment subscale is considered the self-report measure of intrinsic
motivation. The subscales *perceived choice* as well as *perceived competence* are positive predictors of intrinsic motivation, and *pressure/tension* is a negative predictor of intrinsic motivation. The internal consistencies of the subscales are shown in Table 1. All values were acceptable.

Table 1. Subscales of the adapted Intrinsic Motivation Inventory are reported as Cronbach’s Alpha, number of items and example items.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Cronbach’s Alpha</th>
<th>Items</th>
<th>Example item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest/enjoyment</td>
<td>α = .81</td>
<td>7</td>
<td>I enjoyed doing this activity very much.</td>
</tr>
<tr>
<td>Pressure/tension</td>
<td>α = .65</td>
<td>5</td>
<td>I felt very tense while doing this activity.</td>
</tr>
<tr>
<td>Perceived choice</td>
<td>α = .75</td>
<td>5</td>
<td>I did this activity because I wanted to.</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>α = .76</td>
<td>6</td>
<td>I think I am pretty good at this activity.</td>
</tr>
</tbody>
</table>

### 4. Results

The results of the impact of teacher behavior and structure on students’ intrinsic motivation are shown in Table 2. The perceived autonomy shows that when students received by autonomy-supportive teacher behavior, they perceived themselves as much more autonomy-supported. Teacher behavior had an effect on intrinsic motivation that is generally consistent with theory. On the subscale *perceived choice*, we find a moderate positive main effect from autonomy-supportive teacher behavior. Other subscales do not contribute to this overall picture. The effect of provision of structure is not consistent with theory. The only significant main effect is found in the subscale *perceived choice*. Most interesting are the interactions that are significant for each subscale. In the subscales *interest / enjoyment*, *pressure / tension* and *perceived choice* the effects are small to medium; in the subscale *perceived competence* the effect is medium to large. The results show that the predictors of intrinsic motivation are lowest in the treatment CS+. Students in this condition felt the least *interest / enjoyment*, *perceived choice*, the least *perceived competence*, and the highest *pressure / tension*. 
Table 2. Means (M) and standard deviations (SD) for the perceived autonomy, as well as the subscales of the adapted intrinsic motivation inventory in the post-test, are shown for all combinations of autonomy-supportive (A) and controlling teacher behavior (C) with different levels of structure, i.e., basic structure (S) and extensive structure (S+). Reported is a MANOVA with main effects of teacher behavior and structure and the interactions of teacher behavior x Structure in all subscales.

<table>
<thead>
<tr>
<th>Subscale</th>
<th>S</th>
<th>S+</th>
<th>Teacher behavior</th>
<th>Structure</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived autonomy</td>
<td>A (M=2.96, SD=0.62)</td>
<td>2.92 (M=0.60)</td>
<td>F(1,108) = 118.30, p &lt; 0.001</td>
<td>F(1,108) = 0.85, p = n.s.</td>
<td>F(1,108) = 0.43, p = n.s.</td>
</tr>
<tr>
<td></td>
<td>C (M=1.78, SD=0.49)</td>
<td>1.59 (M=0.71)</td>
<td>η² = .523</td>
<td>p = n.s.</td>
<td>p = n.s.</td>
</tr>
<tr>
<td>Interest/enjoyment</td>
<td>A (M=2.42, SD=0.78)</td>
<td>2.60 (M=0.95)</td>
<td>F(1,107) = 0.05, p = n.s.</td>
<td>F(1,107) = 0.77, p = n.s.</td>
<td>F(1,107) = 3.97, p &lt; 0.05, η² = .036</td>
</tr>
<tr>
<td></td>
<td>C (M=2.70, SD=0.70)</td>
<td>2.24 (M=0.91)</td>
<td>F(1,107) = 0.05, p = n.s.</td>
<td>F(1,107) = 0.77, p = n.s.</td>
<td>F(1,107) = 3.97, p &lt; 0.05, η² = .036</td>
</tr>
<tr>
<td>Pressure/tension</td>
<td>A (M=1.39, SD=0.84)</td>
<td>1.23 (M=0.96)</td>
<td>F(1,105) = 3.30, p = n.s.</td>
<td>F(1,105) = 0.68, p = n.s.</td>
<td>F(1,105) = 2.91, p = n.s.</td>
</tr>
<tr>
<td></td>
<td>C (M=1.41, SD=0.89)</td>
<td>1.87 (M=1.04)</td>
<td>F(1,105) = 3.30, p = n.s.</td>
<td>F(1,105) = 0.68, p = n.s.</td>
<td>F(1,105) = 2.91, p = n.s.</td>
</tr>
<tr>
<td>Perceived choice</td>
<td>A (M=2.33, SD=0.76)</td>
<td>2.28 (M=0.75)</td>
<td>F(1,107) = 5.31, p &lt; 0.05</td>
<td>F(1,107) = 4.33, p &lt; 0.05</td>
<td>F(1,107) = 2.86, p = 0.09, η² = .047</td>
</tr>
<tr>
<td></td>
<td>C (M=2.24, SD=0.77)</td>
<td>1.68 (M=0.87)</td>
<td>η² = .047</td>
<td>p = n.s.</td>
<td>η² = .047</td>
</tr>
<tr>
<td>Perceived competence</td>
<td>A (M=2.56, SD=0.67)</td>
<td>2.79 (M=0.72)</td>
<td>F(1,105) = 0.31, p = n.s.</td>
<td>F(1,105) = 1.60, p = n.s.</td>
<td>F(1,105) = 8.13, p &lt; 0.01, η² = .072</td>
</tr>
<tr>
<td></td>
<td>C (M=2.90, SD=0.70)</td>
<td>2.29 (M=0.93)</td>
<td>p = n.s.</td>
<td>p = n.s.</td>
<td>p = n.s.</td>
</tr>
</tbody>
</table>

5. Discussion and conclusion

The aim of our study was to examine the impact of teacher behavior and structure on students’ intrinsic motivation. In a non-formal setting, autonomy-supportive and controlling teacher behavior, and basic and extensive structure have been combined to construct a learning environment according to the CMoL (Falk & Dierking, 2000; 2016) and SDT (Deci & Ryan, 2002) theories. The study evaluated the quality of students’ motivation while visiting an exhibition. The two factors, teacher behavior and structure, were each varied in two levels. According to the theoretical assumptions, effects were expected as follows: autonomy-supportive teacher behavior has beneficial effects on intrinsic motivation through the support of the basic need for autonomy, and (extensive) structure is beneficial for intrinsic motivation through the support of the basic need for competence. The analysis showed that the main effects for teacher behavior and structure found cannot be regarded as major evidences in favor or against the theoretical assumptions, yet significant interactions suggest that both factors may be complementary and mutually supportive dimensions.
Regarding the main effect of autonomy-supportive teacher behavior, this theory is supported by the significant effect of autonomy-supportive teacher behavior for the subscale perceived choice. Stronger evidences were found in previous studies (Basten, Meyer-Ahrens, Fries, & Wilde, 2014; Eckes & Wilde, 2016). The effect size is nevertheless near a medium effect range. Students of higher types of tracking may react differently to both teaching styles, either because they are used to stricter teaching styles or are already used to autonomy-supporting styles. A possibly beneficial effect of the treatment structure for students of higher types of tracking can only be examined by analyzing the interactions of both factors.

The results suggest that autonomy support through teacher behavior and competence support through structure did not have separate effects on students’ motivation. As described, the effects of both factors overlap in reference to the three contexts of CMoL. Teacher behavior presumably influences the components of the sociocultural and the personal context. Structure, on the other hand, influences the components of the physical and presumably the personal context. As we are assessing students’ motivation situated in the personal context, an interaction between both factors is very reasonable.

As the significant interactions of all subscales suggest, the combination of both factors is most interesting. Perceptions of teacher behavior and structure were dependent on one another. Two very different combinations seem to be effective for students’ motivation. The first one was autonomy-supportive teacher behavior combined with extensive structure (AS+). This combination achieves exactly what SDT states: Autonomy-supportive teacher behavior fosters students’ perceived autonomy (e.g. Grolnick & Ryan, 1987). Extensive structure might fulfill the students’ need for competence (Connell & Wellborn, 1991). Both perceived autonomy and perceived competence facilitate intrinsic motivation (Deci & Ryan, 2002). Regarding the non-formal setting, the combination of autonomy support and extensive structure is likely to support students in their interaction with the effects of the settings’ novelty, and may prevent disorientation or distraction.

The second combination that resulted in good qualities of motivation was unexpected. It was basic structure and controlling teacher behavior (CS). In terms of the non-formal setting, the combination of control and basic structure should have led to distracted students that work on non-relevant aspects of the exhibition or try to orient themselves. Furthermore, students’ motivation was expected to be low. It is possible that the high achievers of our sample had a very good idea of how to learn well. They may have already known that a certain level of performance was expected of them. This implicit feeling of pressure might lead to very little tolerance of ambiguity which is enhanced, understandably, when less structure is given. Furthermore, students of young ages are dependent on external feedback and extrinsic reinforcement (Harter, 1981), which is what students often experience in school. Presumably, these students did not mind being told what to do in a controlling way when they did not know what they are supposed to do otherwise. If these controlling instructions from the teachers gave them the external feedback and extrinsic reinforcement they needed to feel competent, it’s no surprise that motivation was not impaired as long as the students felt competent (Harter & Jackson, 1992).

But, what happens when students already know what to do and receive constant further instruction? Here, we need to focus another, less effective treatment combination: controlling teacher behavior combined with extensive structure (CS+). On all subscales, this overload of instructions led to the worst results regarding intrinsic motivation. When students already know what to do, thanks to a structured learning environment where they feel they understand everything, they do not appreciate being told repeatedly (and unnecessarily) what to do and how to do it again and again (Jang et al., 2010).
A limitation to this study is the characterization of the teachers’ instructional style as it focused only on a specific part, yet it is this part in particular that has a tremendous impact on the perceived autonomy. Teacher behavior as a whole is built from many different characteristics and beliefs, some of which are hard to change (Reeve & Cheon, 2016). For the focus of the motivating style, factors such as personality disposition, culture or beliefs are responsible for why teachers orient themselves towards autonomy support or control (Reeve et al., 2014; Taylor, Ntoumanis, & Smith, 2009). Aeltermann, Vansteenkiste, Van Keer and Haerens (2016) state that proposed strategies have to be explained, their effectiveness shown and the necessary tools provided to put them into practice. To enable teachers in our study to recognize the operationalization, i.e., autonomy support and control as feasible teaching styles, teachers were introduced to SDT and trained in applying both behaviors throughout multiple training sessions. In relation to autonomy-supportive and controlling teacher behavior, studies show that teacher-training works for teachers with pre-existing controlling, neutral, and autonomy-supportive styles (Cheon & Reeve, 2013; Cheon, Reeve, & Moon, 2012; Tessier, Sarrazin, & Ntoumanis, 2010). We cannot rule out the influences of teachers’ characteristics as a whole on their autonomy-supportive and controlling behavior. To minimize these effects teachers were instructed in each of the treatments, CS, CS+, AS and AS+. Additionally, students’ perceived autonomy showed that teachers’ teaching style was perceived as either autonomy-supportive or controlling.

In essence, for this high-achieving sample we may need to construct a learning environment that refers to all contexts of the Contextual Model of Learning, which are the sociocultural context (learner-teacher relationship), the physical context (structure) and the personal context (perception of autonomy and motivation), but the learning environment must be adjusted to a beneficial equilibrium. Controlling teacher behavior and extensive structure could provide an excessive amount of instruction that undermines students’ intrinsic motivation.

References


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5.2 Manuskript II: Motivational effects of structure and autonomy support in non-formal learning


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Die Auswirkung von autonomieförderndem Lehrerverhalten im Biologieunterricht mit lebenden Tieren

Natalia Hoffeber · Alexander Ecker · Anastasiya Kovaleva · Matthias Wilde


Schlüsselwörter Motivation · Flow · Autonomie · Kontrolle · Lehrerverhalten · Selbstbestimmungstheorie

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The Effect of Teacher Behaviour in Biology Lessons with Living Animals

Abstract According to the self-determination theory and the flow-theory, perceived autonomy enhances the quality of pupils' motivation while perceived control decreases it. Autonomy support is especially important in hands-on biology lessons. This study thus conducted the motivational impacts on autonomy-supportive and controlling teacher behaviour in biology lessons. The sample consisted of 7th graders ($N=95; M=12.9$ years; $SD=1.6$ years). The three-hour unit was on the Eurasian Harvest mouse (Micromys minutus) and its adaptation to its environment. During the lessons the students' flow experience was measured and after the unit their intrinsic motivation. The results suggest that autonomy supportive teacher behaviour in biology lessons supports flow experience and intrinsic motivation, controlling teacher behaviour does not.

Keywords Motivation · Flow · Autonomy · Control · Teacher behaviour · Self-determination theory

Einleitung

5.3 Manuskript III: Die Auswirkung von autonomieförderndem Lehrerverhalten im Biologieunterricht mit lebenden Tieren


Theorie

Intrinsische Motivation und Flow-Erleben

Die Auswirkung von autonomieförderndem Lehrerverhalten im Biologieunterricht mit lebenden Tieren


Autonomieförderung vs. Kontrolle im Biologieunterricht mit lebenden Tieren


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Hypothesen


Hieraus ergibt sich folgende Hypothese:
5.3 Manuskript III: Die Auswirkung von autonomieförderndem Lehrerverhalten im Biologieunterricht mit lebenden Tieren

H1 Autonomiefördernder Biologieunterricht wirkt sich positiv auf die intrinsische Motivation der Schülerinnen und Schüler aus.

Autonomiereiben begünstigen die Verschmelzung von Handlung und Bewusstsein sowie das Gefühl, Handlungsverursacher zu sein (Bakker et al. 2011). Autonomieunterstützende Kommunikationselemente und die damit einhergehende Leistungsrückmeldung sollten sich positiv auf das Flow-Erleben auswirken (Bakker et al. 2011).

Hierauf ergibt sich folgende Hypothese:

H2 Autonomiefördernder Biologieunterricht wirkt sich positiv auf das Flow-Erleben der Schülerinnen und Schüler aus.

Material und Methoden

Stichprobe


Messinstrumente

Self-Regulation Questionnaire


Flow-Kurzkala


kurzkala intrinsische Motivation

Die Motivation der Schülerinnen und Schüler wurde nach Abschluss der Unterrichtseinheit mit Hilfe der Kurzkala intrinsische Motivation (KIM) erfasst. Die KIM stellt eine Tab. 1 Darstellung der verwendeten Messinstrumente mit jeweils einem Beispiel und der Reliabilität (Cronbachs Alpha α) der einzelnen Subskalen. Hinter jedem Beispiel ist in Klammern die Itemszahl der entsprechenden (Sub)skala vermerkt

<table>
<thead>
<tr>
<th>Messinstrument mit Subskala</th>
<th>Beispieltext</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Regulation Questionnaire</td>
<td>Warum erledige ich meine Hausaufgaben? (6)</td>
<td>0,61</td>
</tr>
<tr>
<td></td>
<td>... weil ich es erledigen muss (4)</td>
<td>0,78</td>
</tr>
<tr>
<td></td>
<td>... weil die anderen Schüler von mir denken sollen, dass ich schluss bin (4)</td>
<td>0,76</td>
</tr>
<tr>
<td></td>
<td>... weil es zu meinem Leben passt (4)</td>
<td>0,90</td>
</tr>
<tr>
<td></td>
<td>... weil ich meine Hausaufgaben gerne mache. (3)</td>
<td>0,89</td>
</tr>
<tr>
<td>Flow-Kurzkala (FKS)</td>
<td>Meine Aktivitäten laufen flüssig und glatt (10)</td>
<td>0,90</td>
</tr>
<tr>
<td>FKS (1. Messzeitpunkt)</td>
<td>Der Spaß macht mir Spaß gemacht. (3)</td>
<td>0,88</td>
</tr>
<tr>
<td>FKS (2. Messzeitpunkt)</td>
<td>Die Tätigkeit im Unterricht hat mich angemessen. (3)</td>
<td>0,90</td>
</tr>
</tbody>
</table>

Ryan und Connell (1989)

Rheinberg et al. (2003)

Wild et al. (2009)
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Versuchsdurchlauf


Ergebnisse

Zunächst interessierte, ob die Schülerinnen und Schüler der beiden Treatmentgruppen zu Beginn der Untersuchung dieselben motivationalen Voraussetzungen hatten. Dazu wurde der RAI-Wert ermittelt. Mögliche Unterschiede zwischen den Schülerinnen und Schüler der beiden Treatments wurden mittels einer einfaktoriellen Varianzanalyse (ANOVA) berechnet. Diese ergab keinen signifikanten Unterschied zwischen den Treatments (F(1,89) = 0,22, p = 0,64, η² = 0,00). Wie erwartet, unterschieden sich die Schülerinnen und Schüler der beiden Treatmentgruppen nicht in ihrer generellen Einschätzung ihres bisherigen Biologieunterrichts bezüglich der wahrgenommenen Selbst- bzw. Fremdbestimmtheit. Die nur leicht positiven RAI-Werte (A-Treatment: M = 1,11; K-Treatment: M = 0,77) deuten darauf hin, dass sich die Schülerinnen und Schüler im Regelunterricht des Faches Biologie wenig selbstbestimmt wahrnehmen.


Abb. 1 Design der Studie in der autonomiefördernden (A-Treatment) und der kontrollierend behandelten (K-Treatment) Gruppe.
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Tab. 2 Operationalisierung der autonomiefördernden (A-Treatment) und kontrollierenden (K-Treatment) Lehrerverhaltens

<table>
<thead>
<tr>
<th>A-Treatment</th>
<th>K-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informierendes Feedback: z. B.: „Ihr habt das Klettverhalten der Maus gut beobachtet.“</td>
<td>Kontrollierendes Feedback: z. B.: „Ihr habt die Aufgabe so bearbeitet, wie ich es wollte.“</td>
</tr>
<tr>
<td>Vermeidung externer Druckbedingungen: Unterrichtseinheit wurde nicht benotet.</td>
<td>Externe Druckbedingungen: Unterrichtseinheit wurde benotet</td>
</tr>
<tr>
<td>Autonomiefördernde Aussagen: Es wurden die Wendungen „Ihr könnt...“, „wenn ihr wollt...“ verwendet.</td>
<td>Kontrollierende Aussagen: Es wurden die Wendungen „Ihr müsst...“, „Ihr sollt...“ verwendet</td>
</tr>
<tr>
<td>Freie Zeitentstehung: Schülerinnen und Schüler konnten in den Unterrichtsstunden die Zeit, die sie für die jeweiligen Aufgaben investiert, selber einstellen.</td>
<td>Festgelegte Zeitangaben: Die Schülerinnen und Schüler sollten die Aufgaben in der von der Lehrperson vorgegebenen Zeit erledigen</td>
</tr>
</tbody>
</table>


Diskussion

In der vorliegenden Pilotstudie begünstigte Autonomieförderung seitens der Lehrperson die innere Motivation und das Flow-Erleben der Schülerinnen und Schüler im Biologieunterricht, während kontrollierendes Lehrer-

Tab. 3 Effizienzstärken (partielleEta-Quadrat = η²), F-Werte, Mittelwerte (M) und Standardabweichung (SD) der autonomiefördernden (A-Treatment) und der kontrollierend behandelten (K-Treatment) Gruppen in den Subskalen der Kurzskaala intrinsischer Motivation (KIM) sowie die Werte der Flow-Kurzskaala (FKS) zum ersten und zweiten Erhebungszeitpunkt

<table>
<thead>
<tr>
<th></th>
<th>A-Treatment M (SD)</th>
<th>K-Treatment M (SD)</th>
<th>F-Werte (p-Werte)</th>
<th>η²</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIM Druck/Anspannung</td>
<td>0,86 (0,60)</td>
<td>1,17 (0,85)</td>
<td>F(1,86)&lt;30,50 (***)</td>
<td>0,26</td>
</tr>
<tr>
<td>Wahrgenommene Kompetenz</td>
<td>2,85 (0,61)</td>
<td>2,00 (0,83)</td>
<td>F(1,86)&lt;82,14 (***)</td>
<td>0,49</td>
</tr>
<tr>
<td>Interesse/Vertiefen</td>
<td>3,39 (0,46)</td>
<td>1,72 (1,00)</td>
<td>F(1,86)&lt;104,63 (***)</td>
<td>0,55</td>
</tr>
<tr>
<td>Wahrgenommene Wahlfreiheit</td>
<td>2,86 (0,62)</td>
<td>1,46 (0,73)</td>
<td>F(1,86)&lt;82,14 (***)</td>
<td>0,49</td>
</tr>
<tr>
<td>FKS (1. Messzeitpunkt)</td>
<td>2,88 (0,48)</td>
<td>1,86 (0,73)</td>
<td>F(1,86)=61,53 (***)</td>
<td>0,41</td>
</tr>
<tr>
<td>FKS (2. Messzeitpunkt)</td>
<td>2,98 (0,65)</td>
<td>1,83 (0,87)</td>
<td>F(1,86)=65,32 (***)</td>
<td>0,43</td>
</tr>
</tbody>
</table>

***p<0,01

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Kritisch zu betrachten sind mögliche Versuchsleitererfekte (Bortz und Döring 2006). Die Versuchsleitern war mit der theoretisch angenommenen Wirkung von autonomieförderndem bzw. kontrollierendem Lehrerverhalten vertraut. Diese Kenntnis kann sich auf das Verhalten des Versuchsleiters auswirken, indem bspw. durch Gestik und Mimik die emotionale Atmosphäre unbewusst zwischen den einzelnen Treatmentgruppen variiert wird (Bortz und Döring 2006). In der vorliegenden Studie sollte das differenzierende Lehrerver-
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Die Auswirkung von autonomieförderndem Lehrerverhalten im Biologieunterricht mit lebenden Tieren


Auszug

Literatur

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Die Auswirkung von autonomieförderndem Lehrerverhalten im Biologieunterricht mit lebenden Tieren


5.4 Manuskript IV: Effects of autonomy supportive vs. controlling teachers' behavior on students' achievements


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Publishing Schedule: EU-JER is published online quarterly in every January, April, June and October in a year.
Effects of Autonomy Supportive vs. Controlling Teachers’ Behavior on Students’ Achievements

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(Grolnick and Ryan (1987) assume that an autonomy supportive environment leads to higher learner engagement and thus to greater achievements and deeper understanding of content. In school, knowledge acquisition (rote learning as well as conceptual learning) are regarded as most important. In this study, we examined the effects of teachers’ autonomy supportive vs. controlling behavior on knowledge acquisition as measured by reproduction as well as at higher cognitive levels. The sample consisted of seventh graders (N = 85, M = 12.85 years, SD = 1.6 years). One week in advance to the teaching unit, the students were tested for prior knowledge using two knowledge tests. Test 1 used multiple-choice items to address rote learning and Test 2 used an open response format to address conceptual learning. One week after the teaching unit, the same knowledge tests were used to assess the learning outcome. Analysis of the knowledge tests suggests that the students taught in an autonomy supportive environment develop greater conceptual knowledge than those taught in a controlling environment. Rote learning was not affected.

Keywords: autonomy, control, teacher behavior, rote learning, conceptual learning, knowledge achievement

Introduction

The purpose of high school is to educate the students to be responsible citizens (Scholl, 2009), who can then apply their knowledge to different contexts. PISA studies (e.g. PISA 2012 in OECD 2013) as well as TIMMS studies (e.g. TIMSS 2012 in Bos, Wendt, Keller, & Selter, 2012) indicate that although Germany has already achieved this goal, there is room for improvement in some areas. A long-standing problem in Germany is that content knowledge acquired in school is not applied to out-of-school contexts (Gerstenmaier & Mandl 1995; Renkl, Mandl, & Gruber, 1996). The implication is that the teaching of content knowledge can be improved. The acquisition of knowledge is dependent on many factors, such as the student’s socio-economic status, the type of school, and motivational factors (Yamasaki, 2011). The latter have a strong effect on the students’ achievements in school, and can be influenced by the teachers’ behavior (Reeve, 1998). Reeve, Bolt, and Cai (1999) argue that a teachers’ approach to teaching can influence the students’ motivational state and their level of achievement. They differentiate between autonomy supporting styles on the one hand, and controlling motivational styles on the other (Reeve, 1998; Ryan & Deci, 2000). Previous studies have suggested the positive effect of autonomy support on students’ motivation (Mousatidis, Lens, & Vamsteekiste, 2010; Reeve et al., 1999). The aim of this study was to compare the effects of teachers’ autonomy supporting and control-
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...ing behavior on the students’ reproducible as well as conceptual learning achievement in biology classes.

Theoretical Background

The teaching environment can be greatly influenced by the teacher (Grolnick & Ryan, 1987). Teachers who promote autonomy offer their students choices, give them informative feedback, and allow them the space to decide for themselves how they want to learn, and so forth (Reeve, 2002; Reeve et al., 1999; Reeve & Jang, 2006). Autonomy support facilitates satisfaction of the need for autonomy, considered one of the basic needs, along with social relatedness and competence. This satisfaction promotes intrinsic motivation. Furthermore, autonomy support is also crucial to the learning process (Deci & Ryan, 1985). Grolnick and Ryan (1987) posit that an autonomy supportive environment can have a positive effect on the students’ interest in taught content, and thus increasing personal relevance for the students. This is thought to lead to higher engagement by the learner (Grolnick & Ryan, 1987), thus enabling more effective learning (Reimmann & Mandl, 2006; Weinert, 1996). Students, who are taught by autonomy supporting teachers develop a deeper understanding of the content (Benware & Deci, 1984; Grolnick & Ryan, 1987), get better grades (Miserando, 1996), learn more and retain the acquired knowledge longer (Bätz, Beck, Kramer, Niestradow, & Wilde, 2009). They also have more endurance while learning (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004) and acquire deeper and more complex knowledge (Müller & Palekšić, 2005) than students, who are taught in controlling environments. Teachers who tend to exhibit more controlling behavior withhold students’ control over their own actions. Specific behaviors include providing explicit instructions for how tasks are to be performed (Assor, Kaplan, Kanat-Maymon, & Roth, 2005), proposing solutions, giving students few or no choices, and put them under pressure to perform in prespecified ways (Reeve, 2002; Reeve et al., 1999; Reeve & Jang, 2006). When students are taught by controlling teachers their perception of autonomy can become impaired. As such, a deeper understanding of the content, marked by confident success and persistence, is undermined (Assor et al., 2005; Ryan, 1982). Nevertheless, the requested actions are carried out under threat of punishment (Assor et al., 2005). Because the motivation to learn is extrinsic, incentives couched in the controlling teachers’ behavior, e.g. reward or punishment, eventually turn the students’ attention away from the central content of teaching. The students focus on “jumping through hoops,” so to speak, often choosing the simplest and quickest solution without real regard to learning (Amabile, 1983; Vansteenkiste, Lens, & Deci, 2006). This can lead to superficial ways of carrying out tasks, without ever reflecting on their significance (McGraw & McCullers, 1979; Ryan, 1982). This way of learning supports the acquisition of inert knowledge (Renkl et al., 1996) and impairs learning as a means to reformulating knowledge in the context of the students’ life, so as to make it applicable to everyday situations. In view of the importance of knowledge acquisition by students, this study investigated whether rote and conceptual learning could be enhanced by autonomy supporting teaching behaviors.

Hypotheses

We hypothesized that autonomy supporting biology lessons would have a greater positive effect on students’ knowledge acquisition as compared to controlling teacher behaviors. We predicted this to be true for (a) reproducible and (b) conceptual knowledge. A positive effect was operationalized as significant differences in the two testing instruments described below.

Methods

Participants

Participants comprised four seventh grade biology classes at two middle schools (Realschule) (N = 85). One class from each school was taught using an autonomy supportive perspective (A-treatment, N = 44) and the other informs a controlling perspective (C-treatment, N = 41). Details of the operationalization
of both perspectives can be found in Table 1 below. The students’ average age was 12.85 years ($SD = 1.6$ years).

**Measuring instruments**

Two knowledge tests were used. The items in the pre- and post-test were identical. In order to avoid ordering effects, the ranking of the items was changed in the post-test. Knowledge Test 1 consisted of 27 multiple-choice items mainly addressingrote learning. Cronbach’s Alpha was $\alpha = .65$. The item difficulty index ranged from .17 to .84. The measured cognitive achievement corresponded to level 1 of the competence area content knowledge (KMK, 2005) and to level 1 as described by Metzger and Nüesch (2004). Both levels include the reproduction of knowledge and reproduction of skills and methods. Knowledge Test 2 consisted of nine open ended items addressing conceptual knowledge. It required short written answers (Lienert & Raatz, 1998). Correct answers were rewarded with two points, incomplete answers with one, and wrong or missing answers with zero points. A maximum of 18 points could be achieved. Inter-rater reliability, determined by Cohen’s kappa coefficient, was $\kappa = .90$. The difficulty index of the items ranged from .31 to .76. Knowledge Test 2 examined students’ cognitive achievement, and was classified as at least level 2 of the competence level content knowledge (KMK, 2005). This level contains the processing of familiar issues in a new context. The students were asked to apply their knowledge to a modified context or to describe it with their own words. This approach corresponds to process level 2 as described by Metzger and Nüesch (2004). For example, the students were expected to be able to explain why the Eurasian Harvest Mouse (*Micromys minutus*) could not climb a tree.

**Design**

This was a quasi-experimental study that used a pre- and post-test design. One week before the teaching unit began both knowledge tests were administered to assess students’ prior knowledge. To accurately measure possible knowledge increases, both tests were repeated one week after the teaching unit. Each teaching unit was three-hours long. There were no differences between the treatments in subject content or teaching methods. The students in both treatment groups worked in small groups with Eurasian Harvest Mice (*Micromys minutus*) and both investigated climbing behavior with respect to the habitats of these very small rodents. Only the teacher’s behavior differed. In treatment A, the teacher was autonomy supportive whilst in the treatment C, the teacher behaved in a controlling manner. To standardize the autonomy support and the controlling teachers’ behavior respectively, the characteristics developed by Reeve (2002) and Reeve and Jang (2006) were analyzed and summarized. The established speeches, feedback and instructions for both treatments were memorized by the teacher before the teaching unit started. The operationalization of the teacher’s behavior in each treatment group is described in Table 1. To ensure the correct implementation of the theory-driven teacher’s statements between and within the treatment groups, all biology lessons taught were recorded. To ensure that the recorded differences were due to the treatment, and not to individual differences between teachers, all classes were taught by the same teacher.

<table>
<thead>
<tr>
<th>Table 1. Operationalization of autonomy supportive (Treatment A) and controlling (Treatment C) teachers’ behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A-treatment</strong></td>
</tr>
<tr>
<td>Informative feedback, e.g.: “You observed the climbing properties of the mouse well.”</td>
</tr>
<tr>
<td>Choice, e.g.: The students could choose their group members and the order in which they wanted to work on their tasks.</td>
</tr>
</tbody>
</table>
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Use of unfamiliar presumably less-controlling symbols, e.g.: The teacher corrected the worksheets with a green pen.
Absence of controlling procedures, e.g.: Students were not given any marks for the unit.
Non-controlling language, e.g.: expressions such as “You could (...)” or “If you want (...)” were used.
Non-controlling organisation of the lessons, e.g.: the students could choose how much time they spent on the tasks within a given amount of time.

Use of familiar controlling symbols, e.g.: The teacher corrected the worksheets with a red pen.
Controlling procedures, e.g.: Students got marks for the unit.
Controlling language, e.g.: expressions such as “You must (...)” or “You should (...)” were used.
Controlling organisation of the lessons, e.g.: students had to finish the task when the teacher told them.

Results
We were interested in rote and conceptual learning. The repeated measures ANOVA showed significant learning improvements with an effect size from pre- to post-test in rote learning for both treatment groups ($F(1, 84) = 32.270; p < 0.001; \eta^2 = 0.278$). Thus, the lessons were successful. However, the main research question of this study was how effective autonomy supportive teaching was in comparison to controlling teacher. In rote learning there were no treatment effects ($F(1, 84) = 0.665; p = ns; \eta^2 = 0.008$; see Figure 1). In order to control for a possible dependence on previous knowledge, we conducted an ANCOVA with previous knowledge as covariate. There was no significant influence of previous knowledge on a possible treatment-dependent learning achievement in the students ($F(1, 84) = 0.002; p = ns; \eta^2 = 0.000$).

Knowledge Test 2 addressed higher cognitive performance levels than Knowledge Test 1. Firstly, we report the effectiveness of the lessons. In both treatment groups, the ANOVA with repeated measures shows a significant and very clear learning advantage from pre- to post-test in Knowledge Test 2 ($F(1, 84) = 454.650; p < 0.001; \eta^2 = 0.844$). There was also a significant time-dependent treatment-effect ($F(1, 84) = 35.246; p < 0.001; \eta^2 = 0.288$; Figure 2). Autonomy supportive teacher behavior seemed to have a significant influence on learning at higher cognitive levels. The possible effect of previous knowledge was again controlled for using ANCOVA, although it revealed no significant influence of previous knowledge ($F(1, 84) = 0.216; p = ns; \eta^2 = 0.003$).
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Learning with and without Controlling Teacher Behavior

Figure 1. Knowledge achievement (multiple choice items). Average and standard deviation of Test 1 at pre- and post-test. A maximum of 27 points could be achieved.

Figure 2. Knowledge achievement (open ended items). Average and standard deviation of Test 2 at pre- and post-test.

Discussion
We were interested in the effects of teacher autonomy supportive and controlling behavior on students with regard to reproducible and conceptual knowledge acquisition. In the study we found significant learning improvements from pre- to post-test in both treatment groups for both types of knowledge. There were no differences in reproducible knowledge between the students who were taught in a controlling context and those taught in an autonomy supportive context. At the higher cognitive level, there
was a meaningful difference between the students who were taught in a controlling context and students who were taught in an autonomy supportive context.

It is a given (e.g. Kroß & Lind, 2001) that students’ prior knowledge can have a significantly influence on growth in knowledge acquisition. Therefore the students’ prior knowledge was assessed at the beginning of the study to ensure that students of both treatments were of a similar level of knowledge. We found an increase in knowledge from pre- to post-test for both treatment groups. In the reproducible knowledge measure, there were no significant differences between the students of the autonomy supportive group and the students who were treated in a controlling manner. This is in line with results by Grolnick and Ryan (1987). For the higher cognitive level, there was a clear treatment effect in favor of the autonomy supportive students. Similar results were found by Grolnick and Ryan (1987). The laboratory study originally conducted by Grolnick and Ryan (1987) was be reproduced in a much more ecological valid context, namely in the real school context of seventh grade biology lessons. In our study, we found that autonomy supportive biology lessons favored the acquisition of conceptual knowledge. Autonomy support promoted a self-determined commitment to the students’ own aims in the unit (Deci & Ryan, 1985 & 2000). Thus, the attention of the learners was much more focused and learning was more active and more effective. This more intense contact with the subject matter is thought to enable deeper, conceptual knowledge (Boggiano, Fink, Shields, Seelbach, & Barrett, 1993). During the controlled treatment group, this level of depth was made difficult because of the interruptions by the teacher (e.g. “Keep the time in mind.” or “You have to finish all tasks.”), the time pressure and the pressure to perform based for school marks (Grolnick & Ryan, 1987; Reeve & Jang, 2006). Controlling teaching appears to affect knowledge acquisition negatively in students (Vansteenkiste et al., 2004). Our study also found that controlling teachers’ behavior appeared to have no negative effect on rote learning while conceptual learning was markedly weaker. In contrast, autonomy support appeared to be equally effective or better than both types of learning. On the whole, autonomy supportive teacher behaviors can be recommended to facilitate deep and effective student learning.

References


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Zeitschrift:  *Research in Science Education* (angenommen)

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The Effects of Collaborative Care of Living Animals in Biology Lessons on Students’ Relatedness Toward Their Teacher Across Gender

Alexander Eckes¹ · Nadine Großmann¹ · Matthias Wilde¹

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Abstract The transition from elementary school to the upper grades can lead to ambiguous feelings toward the new, male teachers. This study investigated whether collaborative animal care in biology lessons affects students’ feelings of relatedness toward their biology teachers positively during the first year after the school transition. Four hundred twenty fifth graders ($M_{age} = 10.5$ years, $SD_{age} = 0.6$ years) of higher types of tracking participated. We designed one experimental group that involved caring for the living animals to be used in the upcoming lessons, and two control groups. The first control group included lessons with living animals, but did not include prior care of those animals, and the second incorporated neither living animals nor prior care. All groups received biology lessons with the same content. To examine the effects of caretaking, we used an adapted version of the scale “relatedness” (Ryan 1982). In both control groups, boys showed lower relatedness toward female teachers and girls toward male teachers, respectively. Collaborative mice care promoted equal relatedness across all gender combinations among teachers and students.

Keywords Student-teacher relationship · Self-determination theory · Relatedness · Living animals · Gender

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Published online: 16 January 2018
Introduction

When students transition from primary school to the upper grades, they experience significant changes in their social environment. These changes coincide with puberty, creating a cumulative load of stress and a corresponding drop in indicators of academic motivation (Blyth et al. 1983; Simmons & Blyth 2009). School transitions can lead to poor student-teacher relationships due to disrupted social networks (Eccles & Midgley 1990). Students are confronted with new student-teacher relationships that are further complicated for many by their first exposure to male teachers (Blasfield et al. 2009). Despite the fact that students need a functional social environment (Higgins & Parsons 1983), students describe post-transition teachers as less warm, less caring, and less friendly (Feldlaufer et al. 1988). Especially in puberty, these characteristics of the post-transition teachers can lead to a dysfunctional student-teacher relationship. Teachers serve as role models, authority figures, and subject matter specialists, and as such significant others in the school setting (Eccles & Midgley 1990). In self-determination theory, significant others are the main focus for perceptions of relatedness. Expectations, wishes, and externally regulated behaviors may be internalized into the students self (Deci & Ryan 2002; Rheinberg 2004). They play an important role in the social development of their students and are jointly responsible for the formation of gender roles (Budde 2006). Relatedness is one of the three fundamental basic needs anchored in self-determination theory (Ryan & Deci 2002, 2017). These basic needs are regarded as crucial to the quality of motivation (Deci & Ryan 2002) and well-being in children (Véronneau et al. 2005). The basic need for relatedness refers to the need of each individual for affiliation to their social environment and to feel accepted and recognized (Krapp & Ryan 2002; Ryan & Deci 2017), and is important for social and emotional development (Solomon et al. 1997). It also affects learning activities and the quality of motivation (Hughes et al. 2008; Ladd et al. 1999, Ryan & Deci 2002). This plays an important role in the context of learning processes in school, as the quality of motivation is quite often extrinsic in nature, although it does not necessarily exclude joy in learning, feelings of self-determination, and positive learning results (Ryan & Deci 2002). Given that caring, supportive social environments are positively related to academic motivation (Solomon et al. 1997), collaborative tasks may help to create caring environments, thereby promoting feelings of community and fostering better student-teacher relationships (Solomon et al. 1997). This might in turn lead to higher perceived relatedness.

Teachers can effectively promote students’ sense of the classroom as a community by creating a caring and cooperative atmosphere, and by finding ways to enhance students’ active participation and engagement in classroom life (Solomon et al. 1997). According to the problem-based learning approach (Barrows 1985; Zimbach 2003) and the learning-community approach (Bielaczyc & Collins 1999), learning environments should be learner-centered with tutorial guidance, embed learning in social contexts and apply authentic problems to influence social-affective as well as cognitive factors positively (cf. Reinmann & Mandl 2006). The use of living animals in biology lessons may enable teachers to create such learning environments. Not only is contact and interaction with animals an inherent desire in children (Gebhard 2013), but relationships and bonds tend to easily form between them (Kellert 1997). Taking care of animals plays a vital role in the development of motivation toward biological problems, the development of positive attitudes toward organisms, and is considered a biological working practice (Gehlhaar 2008). This working practice enables teachers to fulfill one of the basic aims of biology education: to provide students with
immediate contact to organisms that engages multiple senses and is especially effective in enabling students to achieve affective course objectives (Gehrhaar 2008). Since animals can be viewed as valid interaction partners, they pose social problems (Myers 1996; Myers & Saunders 2002) and may work as a social catalyst in the formation of good relationships between students and teachers. The use of living animals and the responsibility for their well-being can create meaningful and collaborative tasks involving the teacher. In turn, this creates an opportunity for increased relatedness between students and teachers, thus improving student-teacher relationships in biology lessons. This study analyzes effects of living animals described above on the relatedness between students and their teachers. In particular, we focus on the relationships between female students and male teachers, and male students and female teachers.

Theory

Relatedness and Motivation

In addition to perceived autonomy and perceived competence, relatedness is one of the basic human needs described in Ryan and Deci’s self-determination theory (Ryan & Deci 2002, 2017). The authors argue that the degree to which these needs are satisfied is correlated to the quality of motivation in individuals. The fulfillment of these basic needs is crucial to the development of personal goals, interests and motives, and supports well-being as well as engagement (Jang et al. 2009; Krapp & Ryan 2002). Deci and Ryan (2002) distinguish between intrinsic and extrinsic motivation and describe a continuum of internalization between these two motivational qualities. Whereas intrinsic motivation arises from interest and satisfaction inherent to the task, extrinsic motivation is fueled by external factors such as grades, rewards, and social constraints (Deci & Ryan 2000). Extrinsicly motivated behavior is performed to attain a state that is separate from the actual behavior (Vallerand & Ratelle 2002). Extrinsic motivation refers to a broad spectrum of motivational regulations that can be categorized into four different types: external, introjected, identified, and integrated (Vallerand & Ratelle 2002). These types differ in their degree of self-determination and some types are more associated with positive educational and developmental benefits than others (Deci & Ryan 1991). According to Deci and Ryan (2000), a person can shift their position along the self-determination continuum of motivation through internalization. It is the more heterogeneous stages of the extrinsic qualities of motivation that rely on a large extent on the need for relatedness. Relatedness may, in fact, secure the internalization of behavioral patterns and the values of significant others (Krapp & Ryan 2002). One of the primary reasons people perform extrinsically motivated actions is because they are prompted, modeled, or valued by significant others to whom they feel (or want to feel) attached or related to. This suggests that the motivational regulation that underlies the extrinsic motivation can be improved by positive feelings of relatedness (Reeve 2002). Ryan et al. (1994) found that children who had fully internalized the regulation of positive, school-related behaviors were those who felt securely connected to and cared for by their teachers. As extrinsic motivation seems to play a significant role in school settings (Reeve 2002), this finding is especially noteworthy. Good relationships with teachers are essential to providing a good and functional social context to establish relatedness, thereby enabling students to internalize external regulations (Ryan & Powlson 1991; Ryan & Stiller 1991; Ryan et al. 1994). According to Ryan (1991), individuals feel
connected to others when their self is accepted. In children, this feeling of belonging is crucial to children because a necessary component in providing them with the security and stability that enables unhindered social and emotional development (Solomon et al. 1997). Classrooms are especially familial areas, as well as contexts of cultural socialization in which children compare their skills and develop their place in the social network (Ryan & Stiller 1991). Children want to feel competent by manipulating their surroundings and are willing to receive practices and knowledge from significant others through mutual interactions (Ryan & Stiller 1991). This includes teachers who are field specific experts within a school context. Meaningful interactions between students and teachers can improve the student’s perception of relatedness (Deci & Ryan 1991; Ryan & Stiller 1991; Ryan et al. 1994). Furthermore, they may foster positive qualities of motivation in class (Knapp & Ryan 2002; Reeve 2002). Positive qualities of motivation can in turn support the students’ knowledge acquisition (Bätz et al. 2009; Reeve et al. 1999). Jung et al. (2009) further showed that the satisfaction of all three needs can lead to greater academic achievement. Furrer and Skinner (2003) found that the students’ relatedness predicted their engagement in class. They describe relatedness as a “key predictor of children’s motivation and performance” (Furrer & Skinner 2003, p. 148).

Relatedness and Gender

Teachers are authorities, role models as well as experts in their field, and set guidelines for social cooperation in the school context (Apple 1982; Buzzelli & Johnston 2001). While interacting with students, teachers play a considerable role in the formation of gender roles (Budde 2006). According to gender socialization theory, certain behaviors and attitudes are reinforced due to the differential treatments given to boys and girls (Fromberg 2005; Koch 2003). This reinforcement of gender roles may be dependent on the gender of the student and the teacher as predicted by gender schema theory (Bem 1981). Once gender role or sex-type is defined, individuals will only incorporate information that is in line with their corresponding gender (Fromberg 2005; Koch 2003; Trumutter 2006). Thus, boys will more easily identify with male teachers, and girls with female teachers, suggesting positive effects for same-gender teachers (Spilt et al. 2012). In most cases, students interact with female teachers in elementary school and lack exposure to male teachers (Blosfeld et al. 2009; Good et al. 1973). During subsequent schooling, it is possible that male and female students might then experience being taught by a male teacher for the first time. Lessons taught by male and female teachers differ (Chavez 2000; Good et al. 1973; Lacey et al. 1998; McDowell 1993). Male teachers tend to ask more process questions, ask more follow-up questions, and give less praise following correct answers (Good et al. 1973). This would require students to cope with a new style of teaching (Duffy et al. 2001; Rashidi & Naderi 2012). Consequently, students can compare their interactions with male and female teachers, and their feeling of relatedness may shift or adapt. According to Hughes and Chen (2011), relationships between girls and teachers may be of higher quality because more teachers are female. Girls tend to show relationships with teachers that are high in support and low in conflict (Birch & Ladd 1997; Hughes & Chen 2011; Hughes et al. 2006; Silver et al. 2005). Relationships between boys and female teachers tend to exhibit less support and more conflict. In addition, male teachers are shown to be more interactive with boys than girls (Rashidi & Naderi 2012). This suggests that the gender of the teacher influences how the differences in post-transition schools are perceived. Furthermore, feelings of relatedness could be dependent on the gender of teacher and student.

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Relatedness and Student-Teacher Relationship

Teachers influence the quality of students’ motivation by providing situations that allow them to fulfill their basic needs (Deci & Ryan 1985, 2000). Bonding with a supportive teacher is a unique kind of relationship, independent from parent- or peer-relatedness, and may lead to increased interest in class, higher social responsibility (Wentzel 1998) and higher engagement in learning activities (Hughes et al. 2008). Several studies have found positive effects of student-teacher relatedness on engagement and achievement in school (Cronne et al. 2004; Kliem & Connell 2004; Ryan et al. 1995; Zimmer-Gembeck et al. 2006). As students transition from elementary to the upper grades, not only does the social framework change, but also their environment, peer-groups, and teachers. The changes in social environment and social culture are especially important (Eccles & Midgley 1990; Higgins & Parsons 1983). These changes lead to a higher risk of cumulative stress and are associated with competition, social comparison, and self-assessment during a period of heightened self-focus. Decision-making and available choices decrease during everyday school life, while the desire to control one’s actions grows (Eccles & Midgley 1989). If a major school transition is combined with puberty, healthy and stable social environments between teachers and students, and among student peers, become increasingly important (Eccles & Midgley 1990; Higgins & Parsons 1983). Consistent with the view elaborated by Higgins and Parsons (1983), Eccles and Midgley (1990) suggest that the unique transitional nature of early adolescence is the result of an interaction between the individuals’ developmental changes and structural changes in the social environments, particularly in schools. They showed that the transition to upper grades leads to gradual decline in various indicators of academic motivation and self-perception over the early adolescent years, as well as a significant drop in students’ relatedness between third and seventh grade (Eccles & Midgley 1990). When compared to elementary school classrooms, upper grade classrooms are characterized by less personal and positive student-teacher relationships, as well as cold, less caring, less friendly, and less supportive teachers (Eccles & Midgley 1989; Feldlaufer et al. 1988). This may undermine a sense of community and lead to feelings of alienation and loneliness (Davidson et al. 2010; Eccles & Midgley 1989; Eccles et al. 1993). Junior high school teachers are often subject matter specialists, and they typically instruct a much larger number of students than elementary teachers in self-contained classrooms, making it less likely they will come to know their students well (Eccles & Midgley 1990). In biology education, teachers are particularly well-educated experts in the correct use of biological working practices, e.g., animal care. Solomon et al. (1997) found that the provision of meaningful, collaborative tasks in a caring and cooperative atmosphere led to greater feelings of community and engagement in classroom life. This caring, supportive, and purposeful social environment was positively related to academic motivation, interpersonal concern, and behavior, and to students feeling supported and valued for who they are (Solomon et al. 1997). Cooperative interaction is a primary mechanism that provides students with opportunities to exert meaningful influence and display and experience positive behavior with their peers. Embedding learning in social contexts, applying authentic problems and designing learner-centered environments with tutorial guidance are especially appropriate to foster social-affective and cognitive factors during the learning process (Barrows 1985; Bielaczyc & Collins 1999; Reimann & Mandl 2006; Zumbach 2003). The use of living animals as authentic experience in a cooperative atmosphere can provide meaningful and collaborative tasks in caring for the animals, and may foster feelings of relatedness in students. This would improve student-teacher relationships, particularly in cases where students must
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adapt to new styles of teaching due to the school transition. Gest et al. (2005) ascribe cooperative, supportive relationships, and feelings of closeness to be important requirements for students to feel related at school (cf. Battistich & Horn 1997). Caring for an animal with the biology teacher may contribute to this kind of relationship and feelings of closeness by offering the possibility to cooperate and interact with the teacher. Feelings of support may also arise due to the fact that the teacher acts as an expert and assists in caring for the animal. Since caring for animals addresses affective domains as well as students' emotions, it may be especially effective in fostering a positive student-teacher relationship and promoting feelings of relatedness, as emotional engagement and feelings of relatedness are correlated (cf. Gest et al. 2005; Ruzek et al. 2016; Skinner & Belmont 1993; see "Motivation, Living Animals, and Biology Lessons" section). Furthermore, Ruzek et al. (2016) showed that emotional support in class can foster students' engagement and mastery motivation.

Relatedness and Living Animals

Animals are part of children’s everyday life and are important for their psychological development. According to Gebhard (2013), the wish to own an animal is one of the most profound childhood desires. Children in particular are able to establish a relationship with animals, and animals tend to be especially trusting toward children (Kellert 1997). Myers and Saunders (2002) see animals in class as a chance to offer possibilities for interactive experiences while taking care of the natural world. The subjectivity and responsiveness of animals make them an option for being put under children’s care (Myers 1998; Myers & Saunders 2002). Their high responsiveness makes them good partners in social interaction and may support students’ feelings of relatedness. In this respect, animals can serve important psychological functions during childhood development (Myers 1996). According to Stern (1985), the key features of children’s core self are sense of agency (the sense of authorship of one’s actions and non-autonomy of those of others), coherence (the sensations of one’s own body), affectivity (the sense of one’s own emotions), and continuity (the sense of continuity in one’s memory). Animals are similar to children’s core self and may in fact be reference points for the self and well-being of children (Myers 1996). The basic dimensions of nonverbal child-animal interactions may be determined using the four features pointed out above (Myers 1996). Myers (1996) attributed four dimensions to animals. First, he deduced that children attribute a sense of agency to animals (Myers 1996). In turn, this behavior can confirm the child’s own sense of agency. Children only feel a sense of agency if they understand themselves to be the initiator and executioner of their own actions (Jeannerod 2003), and perceive themselves as the origin of their behavior (DeCharms 1968). The feeling of being the origin of one’s own behavior can foster the perception of autonomy and increase motivation (Reeve 2002). Much like interhuman interactions, children can receive an assessment of their own self from animals’ responses to their actions. Second, children respond to the body shape and extremities of animals. Children approach and touch animals to gain a tactile sense of body shape, texture, and appendages. Animals possess coherence, which is reflected in children’s readiness to hold them. The experience of the animals’ coherence might be further facilitated by the animal’s lack of language and the practice of naming animals (Myers 1996). Third, children’s actions toward an animal are affected by variations in the animal’s arousal and emotional state, or affectivity (Myers 1996). Children must recognize the vital effects conveyed by animals through nonverbal and verbal cue responses, e.g., the excitement of a dog as shown by non-threatening barking and movement of the body and tail, and then interpret such signals and act
appropriately. Fourth, lengthened interaction with the same animal allows children to experience regularity in the first three features and helps them establish patterns, thereby enabling the dimension of continuity. Myers (1996) determines child-animal interaction in the context of inter-human interaction as a facilitator of interaction. If all four traits are met in an interaction partner, such as an animal, Myers (2006) suggests that children may be more inclined to feel morally concerned with the respective other. Teachers may, in this case, function as facilitators between animals and children (Levinson & Mallon 1997). This could be not only beneficial to the relationship between child and animal, but particularly to the relationship between child and teacher. Biology lessons via caring for animals could offer students genuine, authentic experiences through biological working practices, and provide meaningful student-teacher interactions that may foster affective learning and motivation (cf. Gehlhaar 2008; Killermann et al. 2005).

**Motivation, Living Animals, and Biology Lessons**

Interest and motivation toward natural sciences decrease over students’ school life (Blyth et al. 1983; Hidi & Harackiewicz 2000; Krapp & Prenzel 2011; Simmons & Blyth 2009), changing from a state of intrinsically motivated exploring, joy in learning and a wish to satisfy their curiosity (Deci & Ryan 1985; White 1959), to a state where learning becomes more akin to work than an exciting and rewarding activity that is part of growing up (Hidi & Harackiewicz 2000). This also affects biology education (Prokop et al. 2007). These motivational shifts may start as early as between grades 3 and 6 or grades 3 and 8, and continue over the course of secondary school (Baumert & Köller 1998; Lepper et al. 1997). Learning that is based on interest and self-determined motivation leads to the use of more deep processing-strategies and higher knowledge acquisition (Reeve et al. 1999; Schiefele 2001). This makes support for students’ interest and motivation even more necessary. One possible way to achieve this in biology lessons is to include living animals. The use of living animals introduces a very important didactic principle that allows biology teachers to apply the biological working practices of observation, examination, inquiry, experimentation, and care-taking, while focusing on Primärerfahrungen (Klingenberg 2014). Primärerfahrungen means enabling students to have direct contact and interaction with living objects like animals or plants in biology lessons, serving as a source of scientific inquiry. According to Klingenberg (2014), they should be included in biological learning environments, as they have a strong relation to learning with multiple sensoric and emotional aspects (cf. Kattmann 2008). The term Primärerfahrungen needs to be contrasted from Dewey’s (1995) “primary experience”, as well as translations like “hands-on experience” or “direct experience”. It refers to an educational method of direct interaction with the original object as the subject matter, which leads to greater interest in this object (Hummel & Randler 2012). In the case of Primärerfahrungen, the real object becomes the subject matter and is no longer limited to Sekundärerfahrungen (secondary experiences), like texts, figures, or videos of the object. This direct interaction facilitates more motivation than teaching material which only allows secondary experiences (Hofferber et al. 2016). This enables biology teachers to create learning environments that facilitate immediate contact with organisms, address multiple senses, and reach affective course objectives (Gehlhaar 2008; Killermann et al. 2005). Furthermore, the working method care is exclusively anchored in biology education and would support students’ motivation even further by supporting their
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perception of relatedness (cf. Crosnoe et al. 2004; Klem & Connell 2004; Ryan et al. 1995; Zimmer-Gembeck et al. 2006). Caring for animals can quickly engage students’ emotions and offer possibilities for education in responsible behavior regarding their care (Gehlhaar 2008; Killermann et al. 2005). Given the fact that feelings of relatedness and emotional engagement are correlated, the care of living animals could provide an appropriate tool for fostering students’ feelings of relatedness (cf. Gest et al. 2005). Living animals and responsibility for their care can further offer the opportunity to experience authenticity and connect to students’ everyday life in biology lessons (Gehlhaar 2008; Killermann et al. 2005). These aspects are assumed to enhance students’ motivation (cf. Reeve 2002; Su & Reeve 2011).

Research Questions

In student-teacher relationships, problems may arise after the transition from elementary to upper grades and may lower students’ feelings of relatedness. These problems could be associated with the teachers’ gender. Research has shown that lessons taught by female and male teachers are different (Chavez 2000; Good et al. 1973; Lacey et al. 1998; McDowell 1993). In most cases, students are very familiar with female teachers while often being unaccustomed to male teachers. For the first time after their school transition, students have the chance to experience and evaluate classes taught by different teacher genders in comparison to one another. The additional formation of gender roles during the school transition may lead to problematic relationships with teachers of the opposite gender. According to gender schema theory (Bem 1981), gender roles may lead to positive effects on students when interacting with same-gender teachers. This leads to the following research question.

Research question 1: Are there differences in the relatedness of male and female students toward their female and male teachers respectively?

Following the school transition, less caring and less supportive conditions between teachers and students (Feldlaufer et al. 1988) are created by a new social environment, school structures, and tension between girls and male teachers, and boys and female teachers. To improve these conditions, a caring and supportive social environment should be established (cf. Solomon et al. 1997). This could foster better student-teacher relationships, contribute to a caring atmosphere and promote feelings of relatedness. Such an environment can be created through the collaborative care of animals, which is a typical working practice in biology education. Biology education offers a valuable opportunity to create such environments while reinforcing its inherent goal, the care of animals. The use of living animals, as well as the responsibility for their well-being, provides meaningful tasks, authenticity (Klingenberg 2014) and effectively addresses emotions (Gehlhaar 2008; Killermann et al. 2005). Therefore, this practice could offer the opportunity to increase students’ relatedness toward their teacher and resolve potential differences.

Research question 2: Can the care of living animals improve social relationships between girls and male teachers and boys and female teachers?
Methods

Sample

In this quasi-experimental study, participants consisted of 420 fifth graders from six German schools of higher types of tracking (212 girls, 208 boys; $M_{age} = 10.5$ years, $SD_{age} = 0.6$ years). Classes were randomly assigned to one of the three treatments. Three male and two female teacher trainees conducted the treatments. Teacher trainees were deliberately chosen instead of the students’ regular biology teachers for the following reasons: students did not know the teacher trainees conducting the intervention, and as such no prior relationship between teacher trainee and student could potentially inhibit the effect of living animals on relatedness. Also, in contrast to the teacher trainees, the regular teachers’ behavior in the class setting has already developed. It is likely that they have defined their own styles of teaching, and those styles may vary between each of them. Teacher trainees, however, are still beginning to develop their own teacher personality. De Rijdt et al. (2012) argue that despite having lower specific knowledge compared to staff, teacher trainees have the advantage of higher cognitive and social congruity with students. In tutoring, teacher trainees’ feedback seems to be very valuable (Cho & Schunn 2007). Expert feedback is often perceived as less helpful (Cho & Schunn 2007), hard to understand, and easily misinterpreted. Yang et al. (2006) argue that experienced teachers use their wide range of domain specific knowledge, and this is not as easily accessible for students. Training for the implementation of lessons, an autonomy-supportive teaching style, and professional handling of the animals was acquired during several meetings prior to the intervention, all to minimize the differences between teacher trainees and teachers (De Rijdt et al. 2012). Teachers’ timetables also would have made it rather difficult to establish the training needed for the intervention and methods required.

Study Design

Classes were randomly assigned to one of the three treatments (care, mice, and laptop) before the intervention. Students in each of the three treatments received the same four consecutive biology lessons (see Fig. 1).

Only students in the treatment care ($n = 146$) took care of the mice at their own classroom during the 4 weeks prior to the lessons with the teacher trainees (see Fig. 1). When installing the cage in the care treatment, students received a brief introduction on how to care for the mice, a feeding plan and an overview of appropriate behaviors with the mice. These instructions were also attached to the cages for future reference. The teacher trainee used the feeding plan to assign pairs of students to the two feeding times each week, so students rotated in their duty to care for the mice. The teacher trainees visited the classes of the “care” treatment once a week for approximately 10 min to answer students’ questions (functioning as an expert) and to supervise feeding the mice with mealworms. Five to seven students usually attended these feeding sessions. After those 4 weeks of caring for the animals, students in the “care” treatment worked with the living mice in the following four consecutive biology lessons (see Fig. 1).

Students of the treatment mice ($n = 125$) worked with the mice during the four consecutive lessons. They did not take care of the mice together with the teacher trainee prior to these lessons.

Students in the laptop treatment ($n = 149$) did not use living animals in the four biology lessons at all. They received the four lesson sequence using laptops to watch short video clips instead of
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<table>
<thead>
<tr>
<th>treatment</th>
<th>care</th>
<th>mice</th>
<th>laptop</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 weeks</td>
<td>taking care of mice in class</td>
<td>no care</td>
<td>no care</td>
</tr>
<tr>
<td>2 weeks</td>
<td>lessons with mice</td>
<td>lessons with mice</td>
<td>lessons without mice</td>
</tr>
</tbody>
</table>

Fig. 1 Design of the study. The study consisted of two control groups ("laptop" and "mice") and one experimental ("care") group. The intervention consisted of four biology lessons over the course of 2 weeks. The questionnaire was administered after the fourth lesson. Only the "care" treatment involved caring for the mice at school for 4 weeks prior to the classes. During the four biology lessons, students in the "laptop" treatment used video clips to work while students in the treatments "mice" and "care" both worked with living mice observing the living animals. The clips showed mice activities or other students’ actions with the mice that corresponded to the respective lessons in the other treatments (see Fig. 1).

In summary, there are two important remarks regarding our treatments. First, students of the mice and laptop treatments did not take care of mice prior to the four consecutive lessons. In those classes, the teacher trainees just introduced themselves 4 weeks before these four biology lessons. Second, the lessons in the treatments care and mice were methodically and thematically identical as both treatments worked with living mice in the four consecutive lessons. In both treatments, the living mice were used as a source of scientific inquiry. As animals were not only hosted in the classroom, but were a subject matter in all the biology lessons, the current study has salience in science education. Biology lessons were planned according to problem oriented guidelines (e.g., problem-based learning; Barrows 1985; Zumbach 2003) with student-centered cooperative group work (e.g., learning-community approach; Bielaczyc

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& Collins 1999). These approaches can also be identified in the 4 weeks of the caring for the mice with the teacher trainee. The four consecutive biology lessons in every treatment offered insight into the life and adaptation of the European harvest mouse (Micromys minutus) (Piochocki 2001; Wilde et al. 2003a, b, 2010) and included four topics (see Fig. 1). The students explored the mice’s morphology and climbing behavior, applying the biological working method observation, and experimented with different foods to investigate mice’s eating habits. They also observed the construction of the mouse’s nest and discovered the advantages of this kind of nest. After learning about their geographical distribution and natural habitat, the students built a cage for the mice that was optimal for their well-being.

After the four consecutive biology lessons, students’ perceived relatedness toward the conducting teacher trainee was assessed with the subscale “relatedness” of the Intrinsic Motivation Inventory (see Fig. 1 and “Questionnaire” section). Teacher trainees were schooled in the contents of the lessons, the schedule, and the working materials to ensure an equal implementation among teacher trainees and treatments. The three treatments classify as two control groups (laptop, mice) and one experimental group (care), and were used to rule out the possibility that the availability of animals during lessons would yield the same effects as the care of animals. The five teacher trainees participated equally in all of the three treatments.

Questionnaire

As teacher trainees and not their regular biology teachers were used for the intervention, the relationship between participating students and their regular biology teacher was not assessed at the beginning of our study. Consequently, the study used a post-test design. The construct “relatedness” was measured at the end of the fourth lesson using an adapted, translated version of the five-item subscale for “relatedness” of the Intrinsic Motivation Inventory (IMI; McAuley et al. 1989; Ryan 1982; Ryan et al. 1990). It assesses participants’ subjective experience related to the teacher—in this case, the teacher trainees—while performing the activity. The items investigated the students’ relatedness toward the teacher trainee, e.g., “I had the feeling that I can trust this teacher”, “I would rather not have anything to do with this teacher in the future.” or “I would like to have contact with this teacher more often”. Students answered using a 5-point rating scale that ranged from “0—not at all true” to “4—very true”.

As a measure of the scale’s reliability, Cronbach’s alpha was calculated: \( \alpha = .83 \).

Results

In our study, we were interested in possible gender-related differences in the perceived relatedness of students toward their teachers. Furthermore, we examined whether participating in animal care would influence students’ relatedness positively. The analysis incorporated three factors: the teacher trainees’ gender, students’ gender, and the three different treatments. As seen in Table 1, data from both control groups revealed the following findings: In the case of female teacher trainees, girls felt more related to their teacher than boys. In the case of male teacher trainees, boys felt more related to their teacher than girls. The exception was the care treatment. In the case of collaborative care, boys and girls did not differ in their perceived relatedness toward female and male teacher trainees.

A 2 × 2 × 3 ANOVA between the three groups laptop \((M = 2.42; SD = 0.93)\), mice \((M = 2.50; SD = 0.94)\), and care \((M = 2.76; SD = 0.77)\) showed significant treatment differences for
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<table>
<thead>
<tr>
<th>Teacher trainee gender: female</th>
<th>Student gender: female</th>
<th>Student gender: male</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>&quot;Laptop&quot;</td>
<td>2.65</td>
<td>0.72</td>
</tr>
<tr>
<td>&quot;Mice&quot;</td>
<td>3.05</td>
<td>0.79</td>
</tr>
<tr>
<td>&quot;Care&quot;</td>
<td>2.58</td>
<td>0.81</td>
</tr>
<tr>
<td>Total</td>
<td>2.70</td>
<td>0.77</td>
</tr>
<tr>
<td>Teacher trainee gender: male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Laptop&quot;</td>
<td>2.20</td>
<td>0.84</td>
</tr>
<tr>
<td>&quot;Mice&quot;</td>
<td>2.11</td>
<td>0.77</td>
</tr>
<tr>
<td>&quot;Care&quot;</td>
<td>2.66</td>
<td>0.81</td>
</tr>
<tr>
<td>Total</td>
<td>2.33</td>
<td>0.84</td>
</tr>
</tbody>
</table>

The students’ relatedness toward the teacher trainees ($F(2,408)=6.371$, $p=0.002$, partial $\eta^2=.030$). Scheffé post hoc tests revealed significant differences between the experimental care treatment and both of the control groups (care to laptop $p=0.003$; care to mice $p=0.043$), whereas the control groups did not differ from one another (laptop to mice $p=0.726$). Without taking the effects of students’ gender or teacher trainees’ gender into account, the data showed that students had benefited in their relatedness, especially if they took care of the mice prior to the lessons. The main effect for student gender was not significant ($F(1,408)=0.056$, $p=0.812$), as boys and girls showed no difference in perceived relatedness. The main effect for the teacher trainees’ gender was also not significant ($F(1,408)=0.464$, $p=0.496$), showing that the gender of the teacher trainee showed no significant influence on perception of relatedness. Yet, the data showed a significant interaction between teacher trainees’ and students’ gender ($F(1,408)=25.713$, $p=0.001$, partial $\eta^2=.059$). The perception of relatedness seemed to be dependent on both genders. Interactions for students’ gender and treatment, as well as teacher trainees gender and treatment, were not significant ($F(2,408)=2.034$, $p=0.132$ and $F(2,408)=0.205$, $p=0.815$). There seemed to be no linked effect for gender with time, student, or teacher trainee when crossed with the perception of relatedness. The interdependence of both the gender factors and the treatments appeared to be important, as the triple interaction between teacher trainees’ gender, students’ gender, and treatment was significant ($F(2,408)=6.279$, $p=0.002$, partial $\eta^2=.030$). The highest hierarchical level, the triple interaction, was used for further interpretation. For an even more detailed analysis, we used

### Table 1
Mean scores ($M$) and standard deviations (SD) for perceived relatedness toward teacher trainees are shown for boys and girls taught by either female or male teacher trainees. All data is split into the treatments "laptop," "mice," and "care".

<table>
<thead>
<tr>
<th>Gender</th>
<th>(I) treatment</th>
<th>(J) treatment</th>
<th>$(I-J) M_{difference}$</th>
<th>SE</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>Laptop</td>
<td>Mice</td>
<td>-0.016</td>
<td>0.336</td>
<td>0.962</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Laptop</td>
<td>0.819**</td>
<td>0.261</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Mice</td>
<td>0.803*</td>
<td>0.336</td>
<td>0.017</td>
</tr>
<tr>
<td>Girls</td>
<td>Laptop</td>
<td>Mice</td>
<td>-0.401</td>
<td>0.298</td>
<td>0.178</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Laptop</td>
<td>-0.070</td>
<td>0.231</td>
<td>0.072</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Mice</td>
<td>-0.471</td>
<td>0.307</td>
<td>0.126</td>
</tr>
</tbody>
</table>

* $p < .05$

** $p < .01$
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<table>
<thead>
<tr>
<th>Gender</th>
<th>(I) treatment</th>
<th>(J) treatment</th>
<th>(I-J) $M_{\text{difference}}$</th>
<th>SE</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>Laptop</td>
<td>Mice</td>
<td>-0.223</td>
<td>0.163</td>
<td>0.172</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Laptop</td>
<td>0.510</td>
<td>0.166</td>
<td>0.062</td>
<td>--</td>
</tr>
<tr>
<td>Girls</td>
<td>Laptop</td>
<td>Mice</td>
<td>0.087</td>
<td>0.266</td>
<td>0.603</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Laptop</td>
<td>0.103</td>
<td>0.173</td>
<td>0.553</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Mice</td>
<td>0.411*</td>
<td>0.174</td>
<td>0.012</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>Care</td>
<td>Mice</td>
<td>0.543**</td>
<td>0.166</td>
<td>0.001</td>
<td>0.106</td>
</tr>
</tbody>
</table>

* $p < .05$
** $p < .01$

A simple effect analysis for students’ perception of relatedness toward male and female teacher trainees. The results are presented separately for female (see Table 2) and male teacher trainees (see Table 3). Effect sizes (partial $\eta^2$) were calculated after the simple effect analysis, using sample sizes, mean scores, and standard deviations from each treatment group.

As can be seen in Table 2, girls’ relatedness toward their female teacher trainees was not statistically different between the three treatments. Boys showed significant differences in their relatedness toward female teacher trainees, depending on the treatment. In the treatments laptop and mice, boys showed no difference in their relatedness toward female teacher trainees, but the treatment care showed significant differences from both control groups. The perceived relatedness of boys toward female teacher trainees was significantly higher in the “care” treatment.

As can be seen in Table 3, boys’ relatedness toward their male teacher trainees was not statistically different between treatments. Girls showed significant differences in their relatedness toward male teacher trainees depending on the treatment. In the treatments laptop and mice, girls showed no difference in their relatedness toward male teacher trainees, but the treatment care showed significant differences toward both control groups. The perceived relatedness of girls toward male teacher trainees was significantly higher in the care treatment.

In both situations—boys with female teacher trainees and girls with male teacher trainees—the treatment care resulted in significantly higher perceived relatedness.

Discussion

In our study, we were interested in the students’ feelings of relatedness toward the teacher trainees across gender in biology lessons. Furthermore, we examined the role of animal care in biology lessons to investigate presumed gender-dependent effects on relatedness. Our in-depth analysis suggests that there are gender-related differences in the students’ perceived relatedness. Boys felt less related to female biology teacher trainees and girls felt less related to male biology teacher trainees. Integrating living animals in biology classes has been shown to have positive effects on motivation and learning (Hoffner et al. 2015; Killermann et al. 2005; Meyer et al. 2016; Wilde et al. 2012). Using living animals is a vital element specific to biology lessons and is a source for Primärmaterien (Klingenberg 2014). In accordance with the theory of using animal care as working practice in biology lessons, we found that it fostered positive attitudes toward organisms and can appeal to students on an affective level (Killermann et al. 2005). The treatment that
incorporated living animals in the lessons and prior animal care together with the teacher trainee (care) resulted in much higher relatedness in boys toward female biology teacher trainees and girls toward male biology teacher trainees. Biology lessons using videos on laptops, as well as lessons that incorporated animals but not their care, showed contrasting results. The data suggest that low relatedness and potential problems in student-teacher interaction after the school transition seem to be strongest among boys and female teachers, and girls and male teachers. Animal care seems to diminish this gender discrepancy found in student-teacher relatedness during biology lessons. In this study, caring for mice over a period of time was the crucial factor in reducing discrepancies in relatedness among boys and girls. Contact with male teacher trainees, likely for the first time, affected boys' and girls' relatedness during biology lessons quite differently. Still, the effects of caretaking were higher for boys' relatedness with female teacher trainees than for girls' relatedness with male teacher trainees.

The differences in students' relatedness may be attributed to several causes: comparison of male and female teachers and their teaching after school transition, the number of teachers and time spent per student as well as students developing gender identity.

In most cases, students did not have the opportunity to compare female to male teachers, since the overwhelming majority of teachers in primary school are female (Blossfeld et al. 2009). After the transition to higher grades, students are able to compare teachers of both genders and their classes to one another. The classes of female teachers are different from those of male teachers (Chavez 2000; Good et al. 1973; Lacey et al. 1998; McDowell 1993), and the relationships between female students and teachers, and male students and teachers appear to be different in terms of support and conflict (Birch & Ladd 1997; Hughes & Chen 2011; Hughes et al. 2006; Silver et al. 2005). Both teacher genders in junior high school were characterized as less friendly, less caring, and less supportive (Feldhauer et al. 1988).

Comparing primary to high school, students are confronted with a far greater number of teachers. In addition, teachers spend only a very limited amount of time with their students and teach only one subject (Ecles & Midgley 1990). According to the gender-intensification hypothesis (Hill & Lynch 1983), gender gains importance in early adolescence when the school transition takes place. This may lead to a stronger perception of differences in classes taught by male and female teachers. In addition, students adopt behavior which matches their ideas of their gender identity during early adolescence (Frenberg 2005; Koch 2003; Trautner 2006). Consequently, male students identify with the behavior of male teachers better than the behavior of female teachers, while female students identify their own developed gender identity with the behavior of female teachers. Pubertal development, developing gender identities, and the comparison of female and male teachers may have led to the reported differences in the mice and laptop treatment (Research question 1).

Regarding research question 2, our results suggest that the care of living animals can improve students' relatedness toward the opposite gender. Collaborative animal care could provide teachers with an opportunity to connect with their students, and it is likely to improve student-teacher relationships in biology lessons. Living organisms address students' emotions easily (Gehlhaar 2008; Killermann et al. 2005). Since emotional engagement and the perception of relatedness are highly correlated, engaging emotionally with an animal may have affected students' relatedness toward the teacher trainee in the “care” treatment (cf. Gest et al. 2005). Myer's (1996) dimensions for child-animal interactions, which were most likely satisfied differently in the three treatments, state another possible explanation for our results. As the control group “laptop” did not work with mice at all, none of the dimensions were supported. The second control group, mice, worked with living animals, but only during the four biology lessons. The experimental group care took care of...
the mice at school during the 4 weeks prior to the classes. Both mice and care groups satisfied the dimensions of sense of agency, coherence and affectivity. We suggest that the behavior of animals acknowledges agency in children, and that the provision of the four dimensions sense of agency, coherence, affectivity, and continuity must be ensured to enable animals to act as a social catalyst. The teacher’s role can then move beyond that of an expert and guide, becoming equally interested in the animals, and would in turn lead to increased interest in class (Wentzel 1998). Students’ interest in most school subjects already starts to decline in primary school (Krapp 1998). Considering students’ decreasing interest in science courses, supporting their interest is especially important (Krapp & Prenzel 2011). As teachers help and support students, decisions can be made together, transferring responsibility from teacher to students. This may enable meaningful relationships to form, via animal care, which than leads to caring and responsible behavior from children. Authenticity offered through the care of animals, as well as shared interests between teacher and student, may provide an opportunity to capture students’ interest during a time when interest in natural sciences declines (cf. Krapp & Prenzel 2011). Learning environments that embed these authentic tasks in social contexts, e.g., in a learning community with tutorial guidance of the teacher trainee (e.g., Barrows 1985; Bielaczyc & Collins 1999; Zimbich 2003), are assumed to influence social-affective as well as cognitive factors positively (cf. Reinmann & Mandl 2006). According to self-determination theory (Ryan & Deci 2002, 2017), feeling related can foster students’ motivation and the internalization of external motivation regulations (cf. Ryan & Powelson 1991; Ryan & Stiller 1991; Ryan et al. 1994). Increasing students’ motivation and interest in class is essential for successful learning processes and knowledge acquisition (Reeve et al. 1999; Schiefele 2001).

Regarding the results of this study, some limitations need to be addressed. The first one is the number of investigated teacher trainees. Our study comprises of only three male and two female teacher trainees. This small number of investigated teacher trainees is insufficient for making generalizations. Consequently, the study needs to be replicated on a larger scale. Furthermore, the teachers’ gender cannot be seen as the only factor influencing students’ relatedness. Having a closer look at the construct relatedness, it becomes clear that students’ feelings of relatedness may also be dependent on their relationship to the other students in their class. Zimmer-Gembeck et al. (2006) showed that the teacher-student relationship directly influences the students’ engagement, but there were also indirect effects on students’ engagement for the peer relationships. Furner and Skinner (2003) also found both types of relationships as well as the parent-student relationship as predictors for students’ engagement. Further characteristics of the teacher may have also influenced the students’ relatedness, for example, his or her instructional style or the ability of being empathetic (cf. Battistich et al. 1997; Katz & Assor 2007). It should be kept in mind that we cannot clarify the ways in which the gender of the teacher or the treatment affected the students’ relatedness. We investigated the gender of the teacher as well as the treatment as factors that might affect students’ relatedness in class. It can be asumed that either the gender of the teacher is the mediating factor of the impact of the treatment on the students’ relatedness or that the treatment is the mediating factor of the impact of the teacher gender on the students’ relatedness. This investigation might be subject of further research. As for participating students, it must be noted that characteristics like the students’ socio-economic status or ethnicity might have influenced their relatedness in our investigation (cf. Katz & Assor 2007). These characteristics were not assessed and consequently cannot be considered in our analyses. We assume that these characteristics were equally distributed in the treatments, and that the effects of these characteristics are equally distributed in the treatments as well. However, prospective investigations may take these considerations into account.
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Regarding the conduction of the study, further limitations must be discussed. The teacher trainees were new to the students, and as such they may have inherited an existing, stable classroom culture. This unfamiliar situation might have had an effect on the students’ relatedness as well. Our study focuses on the relation of a certain student to a certain teacher trainee. We therefore believe that this effect is stronger and at the same time more individually changeable than the general classroom culture. In this context, a pretest must be addressed. Focusing the care treatment, our results show no gender-related differences in the student-teacher relatedness in the post test. We cannot rule out that students were already equal in their relatedness prior to the intervention. Though the teacher trainees were not familiar with the students’ initial state of perceived relatedness toward their regular biology teacher in class could have influenced their perceived relatedness toward the teacher trainee during the intervention. Furthermore, assessing the students’ relatedness toward their regular biology teacher may have supported our assumption that there are differences in students’ relatedness toward male and female teachers in regular biology lessons. Lastly, the care treatment itself needs to be discussed. The students of the care treatment had additional contact with the teacher trainee. In each feeding session, five to seven students spent approximately 10 min with the teacher trainee. It should be kept in mind that this extra time was an informal contact and not a regular formal contact during lessons. It is possible that this informal time may also have affected students’ relatedness to some extent.

A feasible consideration is whether the effects in our study may also be found in investigations in other school subjects. As caring for the animal, and therefore extra, informal time spent with the teacher, is addressed for the positive effects on students’ relatedness to the teacher of the different sex, one may conclude that this could be realized in every subject by hosting living animals in class. In this case, the effects may only be attributed to the additional informal time of the particular teacher with their students. Yet, neither the topic the animal represents nor demonstrates nor the subject-specific working methods “care” are incorporated into the curricula of other subjects. In biology courses, the animals act as subject matter during lessons, and the working methods observe and care are exclusively anchored in biology education. Hosting an animal in a classroom in other school subjects would not incorporate the animal into the lesson to its full potential. We assume that the effects of the care treatment can also be attributed to the fact that the students learned about caring for animals from an expert (prospective biology teacher), and that they knew that they would work with the animals in class. This information may have led to personal relevance for the care of the animal, as well as appreciation and increased feelings of relatedness. Nevertheless, prospective investigations might examine the effects of additional informal time with the teacher and animals in other subjects. Furthermore, the effects of long-term collaborative care should be the focus of a larger study and future research.

In our study, differences and similarities might be identified between collaborative care for animals and the concept of animal therapy. First of all, samples investigated in animal therapy often consist of adults and are therefore not easily comparable to the sample in our study. If children are investigated, the studies are often about children that are hospitalized (e.g., Braun et al. 2009; Jalongo et al. 2004; Kaminski et al. 2002). In this case, the settings as well as the physical and psychological states of the children distinctly differ from the students we were investigating. Most of the times, studies have included therapy dogs with special training (Friesen 2010; Jalongo et al. 2004). Especially the intelligence, training and responsiveness of dogs in comparison to the mice in the current study raise questions about the comparability of these studies with our study.
Evidences for positive influences of animal therapy on physiological parameters are reported repeatedly in the literature (e.g., Falk & Wijk 2008). More in line with our research are the findings for psychological parameters. The findings show that animal therapy can affect feelings of loneliness (Brodie & Biley 1999) and the development of a therapeutic rapport through social facilitation positively (Arkow 1998; Fine 2006; Netting et al. 1987). For adults, bonds with animals have been shown to promote social interactions and behaviors, increase emotional comfort, decrease loneliness, and anxiety, and provide a source of self-esteem and a sense of independence (Burke & Dawson 1998; Brokkel 1979; Calver 1989; Churchill et al. 1999; Cole & Gauwinski 1995; Fick 1993; Holcomb & Meacham 1989; Kongable et al. 1989; Zisselman et al. 1996).

Friesen (2010) as well as Jalongo et al. (2004) state that animal therapy is also applicable to educational settings. In the classroom setting, studies show that interactions between animals and children can lead to emotional and social benefits (Zasloff et al. 1999) and contribute to the students’ self-esteem by providing a friend to bond with (Zasloff et al. 1999). Further, students tend to be more attentive, more responsive, and more cooperative with an adult when an animal like a dog is present in the classroom (Limond et al. 1997). Zasloff et al. (1999) report that a huge variety of animals are kept in classrooms ranging from arthropods, annelids, amphibians, reptiles, fish, birds, and mammals. Participating teachers in these studies listed “enjoyment and bonding between children and animal” and “contributions to self-esteem and emotional attachment” as advantages of classroom animals. Bonding between students and teachers as well as between the students might be close to the relatedness in our study.

Considering the self-determination theory, Kurdek (2008) showed that animal keeping satisfies pet owners’ psychological needs. Allen (2003) and Herzog (2011) termed this the “pet effect”. Studies of Karet-Maymon et al. (2016) as well as McConnell et al. (2011) indicate that a need satisfaction with an animal is positively related to a need satisfaction with a close other. This suggests that a relationship with an animal may complement relationships with close humans such as family and friends rather than compensate for them. This may also be true for the teacher.

The students’ relatedness plays an important role in the internalization of attitudes, norms, and values in externally motivated environments (cf. Rheinberg 2004), which the school often represents for students. The satisfaction of the students’ basic need for relatedness is one of the prerequisites for positive qualities of motivation, which in turn are essential for successful learning processes (Jang et al. 2009; Reeve 2002; Reeve et al. 1999). Furrer and Skinner (2003) even characterize it as an essential predictor of motivation and engagement in class. We conclude by proposing that collaborative care for animals in the classroom could offer an appropriate tool for improving student-teacher relationships by fostering students’ relatedness. Using animals in class might help to create a caring and cooperative atmosphere in the classroom. Caring for an animal as conducted in our study allows the collaboration with other students, giving and receiving help from others, the experience of fairness, respect and appreciation as well as taking responsibility. These instructional elements are central to fostering students’ relatedness in class (cf. Batisticich et al. 1997; Katz & Assor 2007). Our most noteworthy result hints that, compared to regular biology lessons, boys felt much more related to female biology teacher trainees and girls felt much more related to male biology teacher trainees. The collaborative care of animals appears to bridge the gender gap in biology lessons.
Acknowledgements  This project is part of the “Qualitätsoffensive Lehrerbildung”, a joint initiative of the Federal Government and the Länder which aims to improve the quality of teacher training. The programme is funded by the Federal Ministry of Education and Research (funding code: 01J1A1608). The authors are responsible for the content of this publication.

Funding Information  The author “Nadine Großmann” is funded by the German Federal Ministry of Education and Research (funding code: 01J1A1608).

References


5. Manuskripte
5.5 Manuskript V: The effects of collaborative care of living animals in biology lessons on students’ relatedness toward their teacher across gender

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5.6 Manuskript VI: Structuring experiments in biology lessons through teacher feedback

Zeitschrift: International Journal of Science Education (eingereicht)

STRUCTURING EXPERIMENTS IN BIOLOGY LESSONS THROUGH TEACHER FEEDBACK

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Abstract

Besides structured settings, structuring teacher behaviour has been shown to be highly relevant to students learning. Structure is regarded to be important in promoting students’ perception of competence. Offering clear expectations and instructions in combination with feedback might enhance students’ perceived competence. The context chosen for this study were experiments in a scientific discovery learning environment as they offer plenty of opportunities for students to seek feedback while using hypothetical-deductive reasoning to work on their experiments. The aim of this study was to investigate the motivational effects of more- or less- structuring teacher behaviour focusing on informative tutoring feedback. 165 students (50% female, 12.02±0.68 years old) from the sixth and seventh grades of medium and high track German secondary schools took part in the study. In a pretest-posttest design, we tested the effects of basic or informative tutoring feedback on intrinsic motivation, flow experience, and knowledge acquisition. Motivation was assessed using an adapted version of the Intrinsic Motivation Inventory (IMI). For teacher behaviour providing informative tutoring feedback we found beneficial effects on intrinsic motivation and flow. Overall, the pre- and posttest showed that the students acquired knowledge through the course of the intervention.

Key words: motivation, perceived competence, feedback, structure, Self-Determination Theory
Introduction

Experimentation is a complex inquiry-based form of scientific inquiry (cf. Ledermann, 2009). Experiments are part of scientific discovery learning and consist of four central phases of scientific problem solving: a) posing questions, b) setting hypotheses, c) planning experiments and d) interpreting the findings (cf. Abd-el Khalick et al., 2004; Hammann 2004; Klahr, 2000; Koslowsk, 1996). In this study, working on experiments in an open environment is framed by discovery learning (Bruner, 1961). The four central phases of problem solving can be challenging for students. Wrong starts (Carlson, Lundy, & Schneider, 1992; Schauble, 1990) or selecting wrong information (Mayer, 2004) are common occurrences. This may impact the balance between students’ abilities and the difficulty of the corresponding tasks because students may not feel competent enough to solve them. Teacher-provided structure in the form of feedback could facilitate potentially needed support during scientific inquiry (Walpuski & Sumfleth, 2007) and the guidance needed to complete the tasks involved with scientific problem solving (cf. Kirschner, Sweller & Clark, 2006; Moreno, 2004).

The present study focusses on informative tutoring feedback (Narciss, 2004, 2006). This type of feedback consists of strategic information that helps learners to detect errors, overcome obstacles, and apply more efficient strategies to the tasks at hand. Informative tutoring feedback may support task completion in scientific discovery learning through the strategic information that is given and could contribute to the perception of personal causation and competence (Keller, 1983, 1987; Lepper & Chabay, 1985). Supporting competence (Reeve, 2002; Ryan, 1982) positively affects subsequent qualities of motivation (Deci & Ryan, 2002). Self-Determination Theory states that positive qualities of motivation arise when the needs for social relatedness, autonomy, and competence are fulfilled (Deci & Ryan, 2002). The main focus of this study is the need for competence. Individuals perceive themselves as being competent if they have the capacities and skills to achieve their goals (Deci, Vallerand, Pelletier, & Ryan, 1991) and feel successful in interacting with their environment (Deci & Ryan, 2002). In educational settings, providing learners with structure might play a key role to facilitate their perception of competence and influence their motivation (Connell & Wellborn, 1991; Deci & Ryan, 2002; Jang, Reeve, & Deci, 2010; Skinner, Furrer, Marchand, & Kindermann, 2008).

Self-Determination Theory can be linked to flow theory (Csikszentmihalyi & Schiefele, 1993) as it may offer additional insight into evaluating the balance between a task’s requirements and a person’s abilities as well as implications regarding the actions that stem from it. The
flow state is characterized by a state of being focused and absorbed in a smooth-running activity, which feels well under control. (Csikszentmihalyi, 1975, 1988; Rheinberg, Vollmeyer, & Engeser, 2003). According to Csikszentmihalyi (1975, 1988), flow might arise if the requirements of the task and the individual abilities are balanced. The structures of the action as well as the goal need to be clear as well. Additionally, any feedback that is given needs to be consistent and without contradiction.

Problems resulting from a scientific discovery environment (Carlson et al., 1992; Mayer, 2004; Schauble, 1990) could impede one’s perceived competence as well as flow experience due to a potential imbalance of the requirements of the task and the abilities of the individual. Informative tutoring feedback could help to reinstat the perception of competence (Connell & Wellborn, 1991; Grolnick & Ryan, 1987; Jang et al., 2010; Taylor & Ntoumanis, 2007) and fulfil the requirements for the flow state, thus resulting in balance of abilities and task requirements. This can lead to positive qualities of motivation which enables students to achieve an in-depth examination and discussion of working materials and can lead to higher knowledge gains (Deci & Ryan, 2002).

Albacete and VanLehn (2000) point out that several studies have shown that informative tutoring feedback has a positive effect on achievement, yet there is only a rather small body of research on how informative tutoring feedback influences motivation (Hattie & Timperley, 2007; Narciss, 2004). The aim of our study was to investigate the effect of two degrees of structuring feedback (basic or informative tutoring) on students’ intrinsic motivation, flow, and knowledge gain in biology lessons with experiments.

Theory

Scientific discovery learning

The theoretical framework for experimentation in an open learning environment is provided by the inquiry-based and constructivist approach to education and learning that is presented by discovery learning (Bruner, 1961, 1970). In this study we focused on scientific discovery learning. This approach implies planning and conducting experiments as a central feature in scientific domains (de Jong & van Joolingen, 1998). Experiments are one of the methods of inquiry in the field of biology and the most important modality of scientific inquiry. Several authors (Abd-el Khalick et al., 2004; Hammann 2004; Klahr, 2000; Koslowski, 1996) frame the central phases of scientific problem solving as posing questions and hypotheses, planning
an experiment, and interpreting the findings. Experiments are part of scientific discovery learning when these problem-solving steps are implemented.

An open discovery-learning environment provides learners with choices and opportunities to work in a self-determined and independent fashion and enables teachers to adopt a supporting role. However, working in such a learning environment might overtax students (cf. Tuovinen & Sweller, 1999) and the high level of independence it entails may lead to a certain degree of insecurity. Students with a low level of perceived competence may be affected in particular and might not be able to effectively carry out the steps involved in experimentation as a result. False-starts in discovery learning are not uncommon (Carlson et al., 1992; Schauble, 1990). Working independently may lead some students to fail to come into contact with the learning content or to choose the relevant information (Mayer, 2004). As a consequence, some students may feel lost, frustrated, and confused (Brown & Campione, 1994; Hardiman, Pollatsek, & Weil, 1986).

One way to avoid these aforementioned problems is to have the teacher support the students by providing them with a sufficient degree of structure. Specifically, the teacher can offer the learners potentially needed information, guidance and feedback while they work independently on experiments. In our study, two distinct levels of structure, basic feedback and informative tutoring feedback, were investigated to ascertain the optimal balance between teacher-provided structure and scientific discovery learning.

**Structure**

Structure can be viewed on a continuum ranging from a high degree of structure to a complete absence of structure, which is chaos (Jang et al., 2010). Structure describes the amount and clarity of the information about expectations and the way in which students can achieve desired outcomes provided by the teacher (Skinner & Belmont, 1993). This instructional teacher behaviour can be divided into three categories (cf. Brophy, 1986; Skinner, 1995; Skinner & Belmont, 1993; Skinner et al., 2008). The teacher can provide structure by exhibiting clear, comprehensible, explicit, and detailed instructions and expectations (1) by initiating the students’ activities using a well-thought-out action plan (2) and by giving constructive feedback on how to gain control over valuable learning performance (3). Chaos, on the other hand, means that the teacher expresses himself confusingly and inconsistently, does not communicate clear rules and expectations, and demands performance without
showing the student how to achieve the desired outcomes or complete the task(s) at hand (Jang et al., 2010).

Structure needs to be distinguished from controlling teacher behaviour. Controlling behaviour in the form of demands, punishments, and rules are not necessarily parts of structure. A controlling form of structure may impede the involvement of the students (Jang et al., 2010) and thus negatively affect their intrinsic motivation. In contrast, structure, when used autonomously, might support student commitment to the task at hand (Jang et al., 2010). Learners might profit from structure to focus on the tasks at hand and actively choose tasks that are well suited to their abilities and competence (Deci & Ryan, 2002).

According to Walpuski and Sumfleth (2007), structure may improve the work steps during scientific inquiry in the classroom. To account for the scientific discovery environment and the questions that may arise from students while working on experiments, structure is implemented as feedback as it is an invaluable tool to guide students in discovery settings (Kirschner et al., 2006; Moreno, 2004).

**Feedback**

Feedback provides learners with information that allows them to verify the correctness of responses, tasks, or work steps and to evaluate their achieved performance. Feedback is defined as information given to learners conveyed by an agent such as a teacher or a parent relating to specific aspects of a learners’ performance and understanding (Hattie & Timperley, 2007) with the intention of improving their thinking or behaviour and learning performance (Shute, 2008).

This study focuses on a particular type of elaborated feedback, namely informative tutoring feedback (Narciss, 2004, 2006). This type of feedback provides learners with strategic information that guides them towards task completion and may consist of information that help students to detect errors, overcome obstacles, and apply more efficient strategies to continue with a task. The components of strategic information may include cues for retrieving facts or pointing out analogies, possible sources of information, errors and successful strategies as well as asking Socratic questions (Narciss, 2004; Narciss & Huth, 2004). In sum, this strategic information may fulfill Skinner and Belmont’s (1993) demand for structure in that it offers information of high quality and high clarity that is needed to complete assignments. In comparison to other types of elaborated feedback, informative tutoring feedback is presented without immediate knowledge of the correct result. The aim of
informative tutoring feedback is to support learners in solving the task, assignment, or problem with the help of, for example, the teacher through tutoring; the correct responses are only provided if all else fails.

Feedback is used as a form of structure to supply students with the information needed to work independently in a discovery environment (Kirschner et al., 2006; Moreno, 2004). Feedback seems to be particularly effective when it comes to tasks in discovery environments (Moreno, 2004). It allows students to track their performance in relation to the task and adjust their effort and strategy/ies accordingly (Locke & Latham, 1992).

Feedback can have an impact on perceived competence (Connell & Wellborn, 1991; Grolnick & Ryan, 1987; Jang et al, 2010; Taylor & Ntoumanis, 2007). According to Deci and Ryan’s Self-Determination Theory of Motivation (Deci & Ryan, 1985, 2002), the learners’ perception of competence affects the quality of their motivation. Informative tutoring feedback may support task completion in scientific discovery learning through the given strategic information without offering immediate knowledge of the correct result and could contribute to the perception of personal causation and competence (Keller, 1983, 1987; Lepper & Chabay, 1985), which, in turn, might affect the subsequent qualities of motivation positively (Deci & Ryan, 2002).

**Self-Determination Theory**

In their Self-Determination Theory of motivation (SDT), Deci and Ryan (1985, 2002) describe a continuum of motivation that makes a distinction between extrinsic and intrinsic motivation. Extrinsicly motivated behaviours incorporate tasks that are instrumental to separable consequences (Deci & Vansteenkiste, 2004) and do not usually occur spontaneously. Extrinsic behaviours are triggered by external prods, pressures, or rewards. Intrinsically motivated behaviours are defined by curiosity, exploration, spontaneity, and interest in the immediate task itself (Deci & Ryan, 1993) as well as intrinsic regulation and self-determination (Deci & Ryan, 2002). SDT states that there are three basic psychological needs that are inherent to every human being, namely the need for relatedness, the need for autonomy, and the need for competence. The satisfaction of these three needs play an essential role in fostering the positive qualities of interest and motivation (Connell & Wellborn, 1991; Deci & Ryan, 2000; Desch, Stiller, & Wilde, 2016; Hofferber, Eckes, Kovaleva, & Wilde, 2015; Krapp & Ryan, 2002; Skinner et al., 2008). If students’ basic needs are met, engagement in class as well as learning may be promoted (cf. Connell & Wellborn,
Relatedness is the need to feel connected to significant others, social groups, and communities and to feel accepted by them. Autonomy describes an individual's desire for self-determination (Deci & Ryan, 2002; Reeve, 2002). Being autonomous involves perceiving an internal locus of causality. Corresponding actions are based on an inner desire for self-determination (Deci & Ryan, 2002; Reeve, 2002). The need for competence is satisfied when individuals feel successful and effective in their interaction(s) with their environment (Deci & Ryan, 2002; White, 1959). Individuals have the innate tendency to seek out new and challenging experiences to enhance their abilities as well as discover and learn new things (White, 1959). A balance between requirements and individual abilities needs to be met (Danner & Lonky, 1981; Deci & Ryan, 1993). If this balance is found, positive feelings of effectiveness may arise (White, 1959).

Although the openness of the scientific discovery environment is in many ways well-suited toward meeting the three basic psychological needs of the SDT, it can also lead to problems such as false-starts (Carlson et al., 1992; Schauble, 1990) or difficulties in selecting important information (Mayer, 2004). The main cause may be a mismatch between students’ abilities and the requirements of the tasks. Consequently, one’s feelings of competence might suffer. In this study, informative tutoring feedback is utilized to facilitate competence in students. Working on tasks that correspond to a person’s abilities in compliance with the requirements of a task may influence the satisfaction of the basic need for competence (Grolnick & Ryan, 1987; Skinner, 1995; Skinner et al., 2008) and, in turn, might foster intrinsic motivation (Deci & Ryan, 2002).

**Flow theory**

SDT can be linked to flow theory (Csikszentmihalyi & Schiefele, 1993). Flow theory can help us to evaluate the balance of a task’s requirements and a person’s abilities and draw the implications for the resulting actions. According to Csikszentmihalyi (1975, 1990), flow experience is a highly enjoyable autotelic state. Flow can be described as a state of excitement that is fulfilling and enjoyable; it is an experience that is intrinsically rewarding in itself rather than a means to obtain an external reward or goal (Csikszentmihalyi, 2000, 2014; Nakamura & Csikszentmihalyi, 2002).
To be in a state of flow, means to be so engrossed in the activity you are engaged in that you lose your sense of time due to a reduction in reflective self-consciousness (Nakamura & Csikszentmihalyi, 2002). A person experiencing flow is focused and absorbed in a smooth-running activity of which he/she feels well under control (Csikszentmihalyi, 1975, 1988; Rheinberg et al., 2003). Flow has a beneficial effect on performance and can therefore have a positive impact on achievement (Albacete & VanLehn, 2000; Rheinberg, 2008). The flow state is intrinsically rewarding and is desired to be a reoccurring experience.

To experience flow, different conditions must be met (Csikszentmihalyi, 2000; Rheinberg, 2008). The requirements of the task and one’s individual abilities need to be balanced. Moreover, the structure of a task needs to be clear and the acting person needs to have distinct goal. The requirements as well as possibilities of the action have to be unambiguous. Additionally, any feedback that is received needs to be consistent and without contradiction. Flow experiences are impeded by frequent interruptions, superficial processing resulting from time pressure, or a bad social climate (Rheinberg, 2008). Disturbances such as the imbalance of abilities and requirements or challenges associated with problem solving should therefore be minimized. If these obstacles are prevented in an activity, then it fulfills the prerequisites to support the flow experience (Csikszentmihalyi, 1975). As the external environment plays such a decisive role in achieving a state of flow, active steps can be taken to help learners enter such a state.

The flow experience can be negatively affected by potential problems that could arise in a scientific discovery-learning environment (Carlson et al., 1992; Mayer, 2004; Schauble, 1990). For example, the task may be too difficult for the learner(s) or the task-structure or goals of the experiment might be ambiguous. In such cases, informative tutoring feedback could positively impact the balance between students’ abilities and the difficulty of the corresponding task and reinstate the required conditions of focus and clarity to achieve the flow state.

**SDT and flow theory**

Intrinsic motivation, according to SDT and the flow experience are closely linked (Csikszentmihalyi & Schiefele, 1993). Both theories overlap to a certain extent with regard to certain qualities of motivation. Kowal and Fortier (1999) found a correlation in the measures of intrinsic motivation and flow.
Flow research and theory originate from a desire to understand the phenomenon of an autotelic and intrinsically motivated activity that is rewarding in itself (Nakamura & Csikszentmihalyi, 2002). Flow describes a state of complete immersion without self-reflection, an impaired perception of time, and focusses on the moment and the process of the action. By contrast, SDT not only focuses on the process of the action, but also on causes for human behaviour beyond a single point in time against the background of the basic needs for relatedness, autonomy, and competence. The basic needs provide a general framework for the development of extrinsic and of intrinsic motivation. Csikszentmihalyi and Schiefele (1993) infer that these needs may not be sufficient in explaining why very specific actions are carried out based on intrinsic motivation while others are not. Nevertheless, intrinsic motivation is characterized by perceptions of interest and enjoyment as well as persistent feelings of autonomy and competence.

Flow theory offers a specific view of the state of mind of the learner. As previously mentioned, the prerequisites for intrinsic motivation and flow are to a certain extent dependent on external factors such as the learning environment, educational materials, and teacher. The learning setting and the provision of feedback may influence flow and intrinsic motivation differently. Since students can choose tasks that match their skills adequately from a range of possibilities, scientific discovery settings appear to be a suitable means to foster their perception of autonomy and competence as well as enabling a state of flow. However, working independently in scientific discovery settings could potentially overwhelm students, especially if they choose tasks that are ill-suited to their individual abilities. This imbalance of individual abilities and task requirements can result in frustration as the task cannot be handled properly. According to SDT, such a situation would lead to a frustration of students’ need for competence and would thus lead to negative effects on their quality of motivation (Deci & Ryan, 2002). From the perspective of the flow-theory, the flow experience would be hindered by such a situation because of the imbalance between the demands of the task and the learners’ abilities and the lack of clear task structure. In any case, these problems may be prevented by structuring teacher behaviour in the form of feedback that can balance students’ abilities and the difficulty of the corresponding task and as such support one of the conditions of flow and at the same time foster students’ perceived competence (cf. Connell & Wellborn, 1991; Csikszentmihalyi, 2000; Grolnick & Ryan, 1987; Jang et al., 2010; Krombass, Urhahne, & Harms, 2007; Massimini & Carli, 1991; Rheinberg, 2008; Taylor & Ntoumanis, 2007).
Benefits of learning in scientific discovery environments

Through discovery learning, the learner might develop the motivation to engage in the subsequent problem-solving processes (Bruner, 1961). Discovery learning can occur whenever the student is not provided with the correct answer, but rather with materials to solve tasks in an autonomous way. The learning environment of scientific discovery learning is likely to increase the personal relevance of a subject matter for the students as their self-determined actions may support their perception of autonomy. This may lead to higher engagement (Grolnick & Ryan, 1987) and more endurance while learning (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). There is ample evidence that autonomy-support can lead to gains in performance (Boggiano, Flink, Shields, Seelbach, & Barrett, 1993) as well as conceptual understanding (Benware & Deci, 1984; Flink, Boggiano, & Barrett, 1990; Grolnick & Ryan, 1987; McGraw & McCullers, 1979). Autonomy-supportive teacher behaviour can facilitate a deeper understanding of the content (Benware & Deci, 1984; Grolnick & Ryan, 1987) and intense contact with the subject matter is thought to enable a deeper understanding of the subject matter (Boggiano et al., 1993). Knowledge acquired in such a way has been shown to be deeper and more complex (Müller & Palekčić, 2005).

The positive qualities of motivation enable students to achieve an in-depth examination and discussion of learning materials and thus might help them to attain higher knowledge gains (Deci & Ryan, 2002). In scientific discovery learning, the basic needs for autonomy and competence may be supported. This can lead to a more intense contact with the subject matter as well as a deeper understanding of the subject matter acquired during these problem-solving processes (Bruner, 1961).

Hypotheses

Informative tutoring feedback can be used as a means to add structure to biology lessons dealing with experiments using the discovery-learning approach. This type of feedback might help students to interact meaningfully within the scientific discovery learning environment and thus support their perceived competence and positive qualities of motivation.

Hypothesis 1: Offering informative tutoring feedback during experimentation in biology lessons using a discovery-learning environment fosters the intrinsic quality of motivation.
Flow experience is a highly enjoyable autotelic state. Being in the flow state means to be absorbed in a smooth-running activity in which one feels in control (Csikszentmihalyi, 1975; Rheinberg et al., 2003). To support flow experience, the structure of an action has to be clear, a goal has to be set, and feedback needs to be consistent and without contradiction.

**Hypothesis 2**: Offering informative tutoring feedback during experiments in biology lessons facilitates flow.

Informative tutoring feedback during experiments in biology might facilitate intrinsic qualities of motivation and flow experience. Both are in line with high quality learning (Boggiano et al., 1993; Deci & Ryan, 2002) and academic achievement (Csikszentmihalyi, 1992; Engeser, Rheinberg, Vollmeyer, & Bischoff, 2005). Moreover in science discovery learning not only learners’ autonomy and engagement with the learning material are of importance but also structure, to enable learners to achieve satisfactory results.

**Hypothesis 3**: Offering informative tutoring feedback during experimentation in biology lessons using a discovery-learning environment supports knowledge acquisition.

**Methods**

**Sample**

The sample of this quasi-experimental study consisted of 165 students (50% female) from grades six and seven from medium and high track secondary schools. The average age of the participants was 12.02 (SD = 0.69) years old. This study used a pretest-posttest design. The students received either a basic level of feedback from the teacher trainee ‘F’ (n = 88) or informative tutoring feedback ‘F+’ (n = 77). The participating classes were randomly assigned to the treatments. To establish optimal contact with feedback for the students, the teacher trainees worked in tandem. The teacher trainees were biology students in advanced semesters of their studies that were trained in providing feedback and the autonomy-supportive teaching style in several meetings prior to the intervention. There are two reasons why we chose to use teacher trainees instead of fully-trained teachers in our study. First, their
interpersonal style is still in development and they are often interested in new teaching techniques (cf. Hoy & Woolfolk, 1990). This makes them ideal candidates for intervention studies that require the acquisition of differing teaching styles. Second, teacher trainees have the advantage of higher cognitive and social congruity with the students (cf. De Rijdt, van der Rijt, Dochy, & van der Vleuten, 2012).

**Study design and intervention**

This study examined problem-oriented experiments on the topic of bird flight that were conducted in an open environment in the participants’ biology lessons. Emphasis was put on formulating and testing hypotheses, analysing data, and drawing conclusions (cf. Abd-el Khalick et al., 2004). The method of open experimentation supported by feedback was used to create a situation of guided discovery. The students worked together with their teacher to establish their research questions and hypotheses. They planned their experiments themselves, worked independently on the experiments they chose, evaluated their findings, and drew conclusions. The interpretation of their results was finally checked with the rest of the students and the teacher at the end of the lesson.

The intervention consisted of three lessons. The students participated in an introductory lesson in which an experiment (birds using thermal lift) was demonstrated by their respective teacher trainee and scientific reasoning was explained using a flow chart for the experiments to visualize the steps of scientific reasoning. The used flow charts were based on Walpuski and Sumfleth (2007) flow charts and modified for this study. The introductory lesson was followed by two subsequent lessons in which the students conducted their experiments in small groups. Experimentation was deliberately chosen as the method in this study as it offers plenty of situations for the teacher trainees to offer feedback while their students worked on their experiments. The students used an experiment set containing several possibilities to conduct experiments on bird flight (Meyer-Ahrens, Birkhölzer, & Wilde, 2012). Students used a flow chart to frame each of their experiments.

Two types of feedback were used to establish the treatment groups. In the basic feedback treatment (F), the students were given the necessary amount of information and expectations needed to work properly. If a student group had problems while working on one of the experiments, the teacher trainees promoted a discussion inside the respective group and withdrew themselves from further involvement. If the problem persisted, the teacher trainees suggested that the student group should work on another experiment and that the problems were going to be discussed at the end of the lesson. In the informative tutoring feedback (F+)
treatment, the students received informative tutoring feedback (i.e., information about their performance and error correction; see Narciss, 2004). If a group in the F+ treatment had problems while working on one of the experiments, the teacher trainees first asked them about their current position on the flow chart. Then feedback was specifically given using clear explanations of the learning materials according to their current position on the flow chart. In addition, the reflective toss technique (Van Zee & Minstrell, 1997) was used to guide student thinking. A reflective toss is part of a sequence of a student statement, a teacher question, and a student elaboration. In a reflective toss, the teacher’s question tries to ‘catch’ the meaning of the student statement and ‘throws’ the responsibility for thinking back to the student (Van Zee & Minstrell, 1997). This may encourage students to elaborate independently on their own questions by making their thinking more visible and allowing teachers to use it as the basis for providing feedback.

Study design and questionnaires

This study used a pretest-posttest design. To control for potential differences in regulation types prior to our study, the students’ degree of self-determination in biology lessons was examined using the German adapted version of Ryan and Connells (1989) Academic Self-Regulation Questionnaire (SRQ-A; Müller, Hanfstingl, & Andreitz, 2007; 4 subscales). In addition, a knowledge test consisting of five closed multiple choice items was assessed. The Flow Short Scale (FSS) was administered (Rheinberg et al., 2003) while the participants work on their experiments during the second and third lessons of the sequence.

In the posttest, two questionnaires were assessed. To control the implementation of structure, an adapted and expanded version of the structure dimension of the Teacher as a Social Context Questionnaire was used (TASCQ; Belmont, Skinner, Wellborn, & Connell, 1988). To measure intrinsic motivation, we used an adapted version of the Intrinsic Motivation Inventory (IMI; Ryan 1982; Ryan, Connell, & Plant 1990). The students answered using a five-point rating scale that ranged from ‘0 - not at all true’ to ‘4 - very true’. The knowledge test consisted of five closed multiple choice items and was re-assessed in the posttest in a randomized item order.

The internal consistencies of the questionnaires used were acceptable except for the external subscale of the SRQ-A (table 1). As the subscale external is only used to calculate the SDI, using not only the external subscale, but all four scales of the SRQ-A. Furthermore, the SDI is only used to give a hint towards the comparability of the two treatment groups. The weak Cronbach’s alpha of the subscale might have only a minor impact.
Table 1. Questionnaires and their respective subscales are shown below. For each (sub-) scale the number of items and the internal consistency is listed. An item example is given for each (sub-) scale.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Subscale</th>
<th>Items</th>
<th>Cronbach’s α</th>
<th>Item example</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRQ-A (pretest)</td>
<td>intrinsic (4)</td>
<td>α = .880</td>
<td></td>
<td>I work and learn in biology lessons at school… …because I enjoy it.</td>
</tr>
<tr>
<td></td>
<td>identified (4)</td>
<td>α = .824</td>
<td></td>
<td>…because I can use the things I learn here for later.</td>
</tr>
<tr>
<td></td>
<td>introjected (4)</td>
<td>α = .699</td>
<td></td>
<td>…because I would have a bad conscience if I only did a little.</td>
</tr>
<tr>
<td></td>
<td>external (4)</td>
<td>α = .480</td>
<td></td>
<td>…because I have to learn it.</td>
</tr>
<tr>
<td>FSS (mid-lesson)</td>
<td>- (10)</td>
<td>α = .846</td>
<td></td>
<td>I feel just the right amount of challenge.</td>
</tr>
<tr>
<td>TASCQ (posttest)</td>
<td>- (13)</td>
<td>α = .882</td>
<td></td>
<td>The teacher clearly explained how the learning materials work.</td>
</tr>
<tr>
<td></td>
<td>interest/enjoyment (7)</td>
<td>α = .850</td>
<td></td>
<td>If I could not solve a problem, my teacher showed me new ways that I could use to solve it.</td>
</tr>
<tr>
<td></td>
<td>pressure/tension (5)</td>
<td>α = .672</td>
<td></td>
<td>I felt very tense while doing this activity.</td>
</tr>
<tr>
<td>IMI (posttest)</td>
<td>perceived choice (5)</td>
<td>α = .666</td>
<td></td>
<td>I felt like it was not my own choice to do this task.</td>
</tr>
<tr>
<td></td>
<td>perceived competence (6)</td>
<td>α = .793</td>
<td></td>
<td>I was pretty skilled at this activity.</td>
</tr>
</tbody>
</table>
Results

This study investigated the effect of two types of teacher feedback on student motivation, flow experience, and knowledge acquisition. An overview of the results is given in table 2.

Table 2. Mean scores (M) and standard deviations (SD) for the FSS, the TASCQ and the subscales of the IMI are shown separately for basic feedback (F) and informative tutoring feedback (F+). Results of an ANOVA for each of the subscales of the adapted IMI follow. P-values are reported in the following α levels: \( p < .001, p < .01, p < .05 \) and not significant (ns), \( p > .05 \). Effect sizes are reported as partial eta square (\( \eta^2 \)).

<table>
<thead>
<tr>
<th>(Sub-)scale</th>
<th>Treatment</th>
<th>M (±SD)</th>
<th>Main effect feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSS</td>
<td>F</td>
<td>2.61 (±0.73)</td>
<td>( F(1,163) = 12.52, p &lt; 0.001, \eta^2 = .071 )</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>2.97 (±0.57)</td>
<td></td>
</tr>
<tr>
<td>TASCQ – structure dimension</td>
<td>F</td>
<td>2.83 (±0.73)</td>
<td>( F(1,163) = 18.78, p &lt; .001, \eta^2 = .103 )</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>3.25 (±0.47)</td>
<td></td>
</tr>
<tr>
<td>IMI - perceived competence</td>
<td>F</td>
<td>2.73 (±0.83)</td>
<td>( F(1,163) = 11.67, p &lt; .001, \eta^2 = .067 )</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>3.11 (±0.56)</td>
<td></td>
</tr>
<tr>
<td>IMI - interest/enjoyment</td>
<td>F</td>
<td>2.70 (±0.90)</td>
<td>( F(1,163) = 3.88, p &lt; .05, \eta^2 = .023 )</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>2.97 (±0.81)</td>
<td></td>
</tr>
<tr>
<td>IMI - pressure/tension</td>
<td>F</td>
<td>1.07 (±0.79)</td>
<td>( F(1,163) = 5.47, p &lt; .05, \eta^2 = .032 )</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>0.79 (±0.77)</td>
<td></td>
</tr>
<tr>
<td>IMI - perceived choice</td>
<td>F</td>
<td>2.80 (±0.81)</td>
<td>( F(1,163) = 2.24, p = \text{ns} )</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>2.97 (±0.64)</td>
<td></td>
</tr>
</tbody>
</table>

We were interested in the effects of basic and of informative tutoring feedback on the motivation and knowledge acquisition of the students. First, we tested the operationalization of the implementation of the teacher structure in the form of two types of feedback using the Teacher as a Social Context Questionnaire (TASCQ). The students in the F+ treatment perceived a higher degree of structure than the students in the F treatment (\( F(1,163) = 18.78, p < .001, \eta^2 = .103 \)). The operationalization of feedback was successful.

To test for potential differences in motivation between the two treatment groups, the Academic Self-Regulation Questionnaire (SRQ-A) was used in the pretest. Derived from the four subscales of the SRQ-A, the self-determination index (SDI) was calculated (Müller et al., 2007). Analysis using ANOVA showed that there was no difference between the treatment
To examine their motivation in detail, two questionnaires were used: the Intrinsic Motivation Inventory (IMI) and the Flow Short Scale (FSS). The analysis of the IMI using ANOVA revealed that the students who received informative tutoring feedback perceived more interest and enjoyment ($F(1,163) = 3.88, p < 0.05, \eta^2 = .023$), perceived themselves as being more competent ($F(1,163) = 11.67, p < 0.01, \eta^2 = .067$), and perceived less pressure ($F(1,163) = 5.47, p < 0.05, \eta^2 = .032$) while working on the experiments. For the subscale perceived choice, we found no difference between basic and informative tutoring feedback ($F(1,163) = 2.24, p = \text{ns}$). Overall, the informative tutoring feedback impacted the students’ motivation positively and had a particularly strong influence on their perceived competence. The ANOVA conducted for the FSS showed that flow-experience was supported for the F+ treatment ($F(1,163) = 12.52, p < 0.001, \eta^2 = .071$). The informative tutoring feedback may have positively impacted the prerequisites of flow.

Table 3. Mean scores (M) and standard deviations (SD) for pre- and post-knowledge test are shown separately for basic feedback (F) and informative tutoring feedback (F+). Results of a mixed ANOVA follow. P-values are reported in the following α levels: $p < .001$, $p < .01$, $p < .05$. Effect sizes are reported as partial eta square ($\eta^2$).

<table>
<thead>
<tr>
<th>(Sub-)scale</th>
<th>Treatment</th>
<th>$M$ (±SD)</th>
<th>Main effect feedback</th>
<th>Main effect time</th>
<th>Interaction feedback*time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge pretest</td>
<td>F</td>
<td>9.69 (±2.77)</td>
<td>$F(1,163) = 13.89$, $p &lt; 0.001$, $\eta^2 = .079$</td>
<td>$F(1,163) = 50.40$, $p &lt; 0.001$, $\eta^2 = .236$</td>
<td>$F(1,163) = 2.83$, $p = 0.09$, $\eta^2 = .017$</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>11.35 (±2.61)</td>
<td>$F(1,163) = 50.40$, $p &lt; 0.001$, $\eta^2 = .236$</td>
<td>$F(1,163) = 2.83$, $p = 0.09$, $\eta^2 = .017$</td>
<td>$F(1,163) = 2.83$, $p = 0.09$, $\eta^2 = .017$</td>
</tr>
<tr>
<td>Knowledge posttest</td>
<td>F</td>
<td>11.99 (±2.56)</td>
<td>$F(1,163) = 13.89$, $p &lt; 0.001$, $\eta^2 = .079$</td>
<td>$F(1,163) = 50.40$, $p &lt; 0.001$, $\eta^2 = .236$</td>
<td>$F(1,163) = 2.83$, $p = 0.09$, $\eta^2 = .017$</td>
</tr>
<tr>
<td></td>
<td>F+</td>
<td>12.77 (±2.78)</td>
<td>$F(1,163) = 13.89$, $p &lt; 0.001$, $\eta^2 = .079$</td>
<td>$F(1,163) = 50.40$, $p &lt; 0.001$, $\eta^2 = .236$</td>
<td>$F(1,163) = 2.83$, $p = 0.09$, $\eta^2 = .017$</td>
</tr>
</tbody>
</table>

A mixed ANOVA (table 3) was used to analyze the knowledge tests assessed on the pre- and posttests. The main effect for time was significant ($F(1,163) = 50.40; p < 0.001; \eta^2 = .236$). The students did acquire knowledge regarding bird flight. The main effect for treatment was also significant ($F(1,163) = 13.89; p < 0.001; \eta^2 = .079$). The students who were supported by the informative tutoring feedback showed significantly higher knowledge gains compared to the students who were supported by the basic feedback. The interaction showed a marginal
significance \((F(1,163) = 2.83; p = 0.09; \eta^2 = .017)\). These results may be attributed to differences between the treatment groups on the pretest.

**Discussion**

In this study we were interested in the effects of informative tutoring feedback on intrinsic motivation, flow experience, and knowledge acquisition. In most of the reported parameters the students were supported by informative tutoring feedback to a larger degree than basic feedback. The students provided with informative tutoring feedback (F+) perceived more intrinsic qualities of motivation (in all subscales except perceived choice), more flow and marginally higher knowledge gains. Preliminary, to control for the implementation of structure, the TASCQ showed that the operationalization of feedback was successful with a medium to large effect size. Within the scope of this study it was possible to establish an effective form of structure.

Informative tutoring feedback was used in this study to facilitate perceived competence in students. The basic need for competence can contribute positively to intrinsic motivation (Deci & Ryan, 2002) when there is congruence between a person’s abilities and the requirements of the task (Grolnick & Ryan, 1987; Skinner, 1995; Skinner et al., 2008). Informative tutoring feedback had a positive effect on three of the four subscales of the Intrinsic Motivation Inventory. The subscale *perceived competence* was the most prominent one, and the effect of informative tutoring feedback was the strongest for this subscale. The *interest/enjoyment* subscale is considered to be the self-report measure of intrinsic motivation. The provision of informative tutoring feedback led to higher *interest/enjoyment* and lower perceived *pressure/tension* in comparison to basic feedback. The subscale *perceived choice* showed no effect for informative tutoring feedback. As autonomy support was identical in both treatments, these findings were to be expected. Providing informative tutoring feedback and structuring the lessons beforehand motivated the students while they worked on the experiments to a larger degree than using basic feedback. Thus, Hypothesis 1 was supported by the findings of our study.

Taking the results of the *perceived competence* subscale into account, the results suggest that informative tutoring feedback is one component to facilitate motivation. The underlying mechanism may be explained by Connell and Wellborn’s model of engagement (1991). In this model the perception of the three basic needs is influenced by the context in which a person is acting. Perceived autonomy is influenced by autonomy support, feelings of
relatedness are influenced by involvement, and the perception of competence is influenced by the structure of the context. Corresponding actions and the person’s engagement depend on the context and the resulting satisfaction of the three basic needs. The positive influence informative tutoring feedback exerted on the quality of motivation can be explained by the effect it has on the students’ perception of competence that they had while working on their experiments in an open learning environment (cf. Connell & Wellborn, 1991). Informative tutoring feedback supplies students with a high amount of clearly-stated and high-quality information, thereby supporting the structure that the context (experimentation in biology lessons) offers (cf. Connell & Wellborn, 1991; Skinner & Belmont, 1993). Furthermore, it provides strategically useful information and enables recipients to apply more efficient strategies (Narciss 2004, 2006; Narciss & Huth, 2004). The structure that the context offers is increased by the informative tutoring feedback. In this way the balance between the requirements of the task and students’ abilities can be met and they can perceive themselves as competent (Danner & Lonky, 1981; Deci & Ryan, 1993). As such, it directly influences the self-system processes that take place in a person when evaluating the fulfillment of the basic need for competence in this particular context (cf. Connell & Wellborn, 1991).

Secondly, we measured flow experience. The results suggest that the student’s flow-experience was supported positively by the informative tutoring feedback. Hypothesis 2 was therefore supported by the results of this study. Offering informative tutoring feedback facilitated their flow-experience in comparison to basic feedback. These results can be analyzed using the conditions and characteristics of the flow state. For flow to occur, a task must challenge an individual at a level that corresponds with one's capacities and any feedback that is given needs to be clear and immediate (Nakamura, & Csikszentmihalyi, 2002). The support of students’ perceived competence might allow them to better judge their abilities with regard to the tasks requirements. In addition, informative tutoring feedback might provide the required immediate and clear feedback. As for the characteristics of flow, the fear of failure in particular may not arise because of the support provided by the informative tutoring feedback is, as we have seen above, intrinsically rewarding (cf. Nakamura, & Csikszentmihalyi, 2002).

Thirdly, we evaluated the knowledge acquisition. The task requirements that a learning environment places on a student can be influenced by prior knowledge (Kalyuga, Chandler, & Sweller, 2001; Sweller, Merrienboer, & Paas, 1998). The students’ prior knowledge was therefore assessed at the beginning of the study. In this respect the samples differed.
As a main effect, we found an increase in knowledge from pre- to posttest for both treatment groups. Without taking the treatment into account, the results for the knowledge test showed knowledge gains for all participating students. As there were already differences between both treatments in the pretest (treatment F+ scored higher than treatment F), the differences between treatment groups in the posttest may only be reproducing the differences that already existed beforehand. The interaction between time and treatment showed a small effect size. The result for the interaction suggests that there may be a dependence of knowledge gain regarding the affiliation to the basic or informative tutoring feedback treatment. To analyze the connection between the provision of feedback and knowledge acquisition in more detail, further studies are needed. Thus, Hypothesis 3 could not be supported as the difference between the treatments may be unrelated to the informative tutoring feedback. They may have been a characteristic of inherent differences between classes in the respective treatments.

In conclusion, the results of the study suggest that providing learners with informative tutoring feedback is more effective in supporting motivation than giving them basic feedback in a discovery-learning environment involving experimentation. Informative tutoring feedback yielded higher qualities of motivation and supported flow-experience as well. The most important finding was the effect this type of feedback had on the learners’ perception of competence, which highlights the influence of feedback on self-system processes in various contexts. The knowledge test showed an overall gain in knowledge for both treatments but no clear evidence for an interaction between the factors feedback and time.

References


5.7 Manuskript VII: Prädiktoren der Kompetenzwahrnehmung von Schülerinnen und Schülern im Biologieunterricht

Zeitschrift:  *Psychologie in Erziehung und Unterricht* (eingereicht)

Prädiktoren der Kompetenzwahrnehmung von Schülerinnen und Schülern im Biologieunterricht

*Predictors of students’ perceived competence in biology lessons*

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²Das – in Teilen diesem Artikel zugrunde liegenden – Vorhaben BiProfessional wird im Rahmen der gemeinsamen Qualitätsoffensive Lehrerbildung von Bund und Ländern aus Mitteln des Bundesministeriums für Bildung und Forschung gefördert (Förderkennzeichen 01JA1608). Die Verantwortung für den Inhalt dieser Veröffentlichung liegt bei den Autor/-innen.
Zusammenfassung


Schlüsselbegriffe: Kompetenzwahrnehmung, Autonomie, Lehrerverhalten, Vorwissen, Selbstbestimmungstheorie

Summary

According to Self--Determination Theory, the satisfaction of the basic need for competence is essential for successful learning. In the current study, possible predictors of students’ perceived competence in a teaching unit in biology were investigated. For this investigation, 136 students (\(M_{\text{Age}}=11.44\pm0.57\) years) participated in a teaching unit on healthy eating. 70 students had a teacher who behaved autonomy--supportively whereas 66 students had a controlling teacher. In the pretest, students’ perceived competence in regular biology lessons and their prior knowledge about the topic of the teaching unit were examined. In the posttest, students’ perceived autonomy and their perceived competence during the teaching unit were assessed. Our results show significant differences in the students’ perception of competence in favor of the students whose teacher behaved autonomy--supportively during the teaching unit. The regression analysis confirms the students’ perceived autonomy and their perceived competence in the pretest as predictors of their perceived competence in the posttest. Students’ prior knowledge cannot be confirmed as predictor.

Keywords: perceived competence, autonomy, teaching behavior, prior knowledge, Self--Determination Theory
5. Manuskripte
5.7 Manuskript VII: Prädiktoren der Kompetenzwahrnehmung von Schülerinnen und Schülern im Biologieunterricht


In der vorliegenden Studie wurde zunächst die Kompetenzwahrnehmung von Schülerinnen und Schülern in einem Biologieunterricht untersucht, der durch die Variation des Lehrerverhaltens (autonomieförderlich vs. kontrollierend) unterschiedliche Grade an

**Theorie**

**Kompetenz und Autonomie im Sinne der Basic Needs Theory**

5. Manuskripte
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der Ort der Handlungsverursachung hingegen intern, nimmt ein Individuum eine Handlung als selbstgesteuert wahr (Reeve et al., 2003).


Prädiktoren der Kompetenzwahrnehmung


Hypothesen


H1) Schülerinnen und Schüler, die autonomieförderlich unterrichtet werden, nehmen sich in der durchgeführten Unterrichtseinheit als kompetenter wahr als Schülerinnen und Schüler, deren Lehrperson sich kontrollierend verhält.


H2a) Die Autonomiewahrnehmung der Schülerinnen und Schüler in der durchgeführten Unterrichtseinheit ist ein Prädiktor ihrer Kompetenzwahrnehmung in dieser Unterrichtseinheit.

H2b) Die Kompetenzwahrnehmung der Schülerinnen und Schüler in ihrem regulären Biologieunterricht ist ein Prädiktor ihrer Kompetenzwahrnehmung in der durchgeführten Unterrichtseinheit.
H2c) Das Vorwissen der Schülerinnen und Schüler über einen Unterrichtsgegenstand ist ein Prädiktor ihrer Kompetenzwahrnehmung in der durchgeführten thematisch entsprechenden Unterrichtseinheit.

**Methode**

**Stichprobe**

136 Schülerinnen und Schüler (\(M_{\text{Alter}}=11.44 \text{ Jahre}; \ SD_{\text{Alter}}=0.57 \text{ Jahre}; 51\% \text{ weiblich}) aus sechs Klassen der sechsten Jahrgangsstufe eines Gymnasiums sowie zweier Gesamtschulen nahmen an einer Unterrichtseinheit zum Thema Gesunde Ernährung teil. 70 Schülerinnen und Schüler wurden autonomieförderlich unterrichtet, während 66 Schülerinnen und Schüler Unterricht bei einer kontrollierenden Lehrperson erhielten. Die Schülerinnen und Schüler wurden zufällig klassenweise den beiden Treatments zugeordnet. Beide Treatments wurden an jeder Schule einmal durchgeführt.

**Messinstrumente**

Perceived Self-Determination
Zur Messung der wahrgenommenen Autonomie der Schülerinnen und Schüler wurde eine adaptierte Version des Fragebogens Perceived Self-Determination (Reeve et al., 2003) im Nachtest eingesetzt (Beispielitem: „Bei diesem Betreuer konnte ich selbst bestimmen, wie ich die Aufgaben bearbeite.“). Die Bewertung der acht Items erfolgte anhand einer fünfstufigen Ratingskala von 0 (stimmt gar nicht) bis 4 (stimmt völlig). Die interne Konsistenz wurde mittels Cronbachs Alpha bestimmt und liegt in einem guten Bereich (\(\alpha=.84\)).

Perceived Competence Scale
Die wahrgenommene Kompetenz der Schülerinnen und Schüler wurde im Vor- und Nachtest mithilfe einer übersetzten Version des Fragebogens Perceived Competence Scale (Williams & Deci, 1996) erhoben. Die drei Items der Skala wurden ebenfalls anhand einer fünfstufigen Ratingskala bewertet (Beispielitem Vortest: „Ich fühle mich sicher bei der Bearbeitung von Aufgaben im Biologieunterricht.“; Nachtest: „Ich fühlte mich sicher bei der Bearbeitung von Aufgaben in dieser Unterrichtseinheit.“). Die internen Konsistenzen im Vor- und Nachtest sind als gut zu bewerten (Cronbachs Alpha: \(\alpha_{\text{Vortest}}=.79\); \(\alpha_{\text{Nachtest}}=.87\)).

Wissenstest

**Design der Studie**

**Abbildung 1. Studiendesign**
Operationalisierung des Lehrerverhaltens


Die Unterrichtseinheit wurde von drei im Studium fortgeschrittenen Lehramtsstudierenden durchgeführt. Vor der Intervention wurden die implementierten Maßnahmen in drei Trainingssitzungen mit diesen Studierenden erörtert und eingeübt. Gegenüber ausgebildeten, berufstätigen Lehrkräften sind Studierende noch relativ flexibel in ihrem Verhalten und haben noch keine gefestigte Lehrerpersönlichkeit ausgebildet (Martinek, 2010; Tessier, Sarrazin & Ntoumanis, 2010). Aus diesem Grund bietet sich ihr Einsatz in Interventionen, in denen das

**Statistische Auswertung**

Die wahrgenommene Autonomie der Schülerinnen und Schüler beider Treatmentbedingungen (Perceived Self--Determination) wurde mittels univariater Varianzanalyse verglichen. Zur Auswertung der Ergebnisse des Fragebogens Perceived Competence Scale wurde auf eine Varianzanalyse mit Messwiederholung zurückgegriffen. Anschließend wurde eine multiple lineare Regression durchgeführt, um die Autonomiewahrnehmung im Nachtest, die Kompetenzwahrnehmung im Vortest sowie das Vorwissen als mögliche Prädiktoren der Kompetenzwahrnehmung im Nachtest zu überprüfen.

**Ergebnisse**

Zunächst interessierte, ob die Implementation des autonomieförderlichen bzw. kontrollierenden Lehrerverhaltens erfolgreich war. Die Ergebnisse der Auswertung des Fragebogens Perceived Self--Determination (PSD; Reeve et al., 2003) zeigen signifikante Unterschiede in der Autonomiewahrnehmung im Vergleich der Schülerinnen und Schüler beider Treatmentbedingungen (Tabelle 1). Schülerinnen und Schüler, die autonomieförderlich unterrichtet wurden, nahmen mehr Autonomie in der durchgeführten Unterrichtseinheit wahr als Schülerinnen und Schülern, deren Lehrperson sich kontrollierend verhielt.
Mittelwerte und Standardabweichungen der wahrgenommenen Autonomie (PSD) und Kompetenz (PCS) sowie die Ergebnisse der Varianzanalysen im Vergleich der Treatments mit autonomieförderlichem (A-Treatment) und kontrollierendem Lehrerverhalten (K-Treatment)

<table>
<thead>
<tr>
<th>Messinstrument</th>
<th>A-Treatment</th>
<th>K-Treatment</th>
<th>Varianzanalyse</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSD (Reeve et al., 2003)</td>
<td>3.17±0.57</td>
<td>2.54±0.78</td>
<td>( F(1,134)=29.86, p&lt;.001, \eta^2=.18 )</td>
</tr>
<tr>
<td>PCS Vortest (Williams &amp; Deci, 1996)</td>
<td>2.46±0.72</td>
<td>2.51±0.84</td>
<td>( \text{Haupteffekt Messzeitpunkt: } F(1,134)=12.41, p&lt;.001, \eta^2=.09 )</td>
</tr>
<tr>
<td>PCS Nachtest (Williams &amp; Deci, 1996)</td>
<td>3.05±0.70</td>
<td>2.48±1.10</td>
<td>( \text{Haupteffekt Treatment: } F(1,134)=4.34, p&lt;.05, \eta^2=.03 )</td>
</tr>
</tbody>
</table>

In den Ergebnissen der Messwiederholung sind signifikante Haupteffekte der Faktoren Messzeitpunkt und Treatment sowie ein signifikanter Interaktionseffekt beider Faktoren erkennbar (Tabelle 1). Vor Beginn der Unterrichtseinheit unterschieden sich die Schülerinnen und Schüler beider Treatmentbedingungen in den Mittelwerten ihrer Kompetenzwahrnehmung (Perceived Competence Scale (PCS; Williams & Deci, 1996) nicht voneinander (\( F(1,134)=0.14, p=\text{ns} \)). Nach der Intervention sind hingegen Unterschiede in ihrer Kompetenzwahrnehmung zugunsten der Schülerinnen und Schüler im Treatment mit autonomieförderlichem Lehrerverhalten erkennbar (Tabelle 1).

Das im Anschluss aufgestellte Regressionsmodell scheint für die Bestimmung möglicher Prädiktoren der Kompetenzwahrnehmung geeignet zu sein (\( R^2=.41, F(3,132)=30.29, p<.001 \)). Die Autonomiewahrnehmung der Schülerinnen und Schüler (\( b=.63, SE_b=.09, t(132)=6.94, p<.001 \)) sowie ihre Kompetenzwahrnehmung im Vortest (\( b=.36, SE_b=.09, t(132)=4.20, p<.001 \)) und Nachtest (\( b=.32, SE_b=.09, t(132)=3.66, p<.001 \)) sind als Prädiktoren der Kompetenzwahrnehmung von Schülerinnen und Schülern im Biologieunterricht relevant.
p<.001) können in diesem Modell als Prädiktoren ihrer Kompetenzwahrnehmung im Nachtest bestätigt werden. Ihr Vorwissen stellt keinen Prädiktor dieser Kompetenzwahrnehmung dar (b=.03, SEb=.04, t(132)=0.78, p=ns).

**Diskussion**

kontrollierenden Treatment wurde auf eine kontrollierende Rückmeldung zurückgegriffen, in
der Arbeitsschritte nach dem Erfüllen oder Nichterfüllen der Erwartung der Lehrperson
bewertet wurden und in der aufgefordert wurde, nachfolgend in einer bestimmten Art und
Weise zu handeln (vgl. Ditton & Müller, 2014; Kast & Connor, 1988; Ryan, 1982). Diese Art
der Rückmeldung erzeugt Druck und vermittelt keine Flexibilität im nachfolgenden
Verhalten. Folglich kann die Wahrnehmung der Komponenten choice und volition im
Treatment mit kontrollierendem Lehrerverhalten negativ beeinflusst und die Wahrnehmung
eines externen Orts der Handlungsverursachung begünstigt worden sein (vgl. Reeve, 2002;
Reeve et al., 2003). Der bedeutsame Rahmen, der im autonomieförderlichen Treatment
gegeben wurde, sollte den Schülerinnen und Schülern die persönliche Relevanz und
Bedeutsamkeit der Handlung im Unterricht aufzeigen. Haben die Schülerinnen und Schüler
diese Relevanz wahrgenommen, könnten sie die Handlungen in der Unterrichtseinheit, im
Vergleich zu den Schülerinnen und Schülern, die diese Rahmung des Unterrichtsgegenstands
nicht erhalten haben, als vermehrt freiwillig und intern verursacht erlebt haben (volition und
internal locus of causality; vgl. Reeve et al., 2003). Da die Komponenten der Autonomie in
einem gegenseitigen Abhängigkeitsverhältnis stehen, kann gleichzeitig die Wahrnehmung der
Komponente choice begünstigt worden sein (vgl. Reeve et al., 2003). Der Einsatz einer
neutralen Sprache ist in der gesamten Unterrichtskommunikation im autonomieförderlichen
Treatment und somit auch in der Rückmeldung, in der Bereitstellung eines bedeutsamen
Rahmens und der Eröffnung von Wahlmöglichkeiten von Bedeutung gewesen. Wurde durch
diese Sprache Flexibilität im Verhalten vermittelt und kein Druck aufgebaut, sich in einer
bestimmten Art und Weise verhalten zu müssen, kann dies die Wahrnehmung der drei
Komponenten volition, choice und internal locus of causality begünstigt haben (vgl. Hofferber
et al., 2016). Die kontrollierende Sprache im Treatment mit kontrollierendem Lehrerverhalten
baute hingegen Druck auf und vermittelte keine Wahlfreiheit. Es wird angenommen, dass
durch diese Sprache die Wahrnehmung der Komponenten volition und choice negativ
beeinflusst und der Ort der Handlungsverursachung als vermehrt extern wahrgenommen
wurde (vgl. Hofferber et al., 2016).
Aufgrund der gegenseitigen Abhängigkeit der Kompetenz- und Autonomiewahrnehmung
kann die Kompetenzwahrnehmung der Schülerinnen und Schüler durch die Implementation
der autonomieförderlichen und kontrollierenden Verhaltensweisen ebenfalls beeinflusst
worden sein (vgl. Deci & Ryan, 1985; Koestner et al., 1987; Krapp, 2005; Krapp & Ryan,
2002; Ryan & Deci, 2002). Konnten Schülerinnen und Schüler im autonomieförderlichen
Treatment selbst bestimmen, wie viel Zeit sie mit welcher Aufgabe verbringen, haben sie


Zweites Ziel der vorliegenden Studie war die Untersuchung möglicher Prädiktoren der Kompetenzwahrnehmung der Schülerinnen und Schüler in der durchgeführten Unterrichtseinheit. Hierzu wurden drei Variablen herangezogen: die Autonomiewahrnehmung der Schülerinnen und Schüler in der Unterrichtseinheit, ihre Kompetenzwahrnehmung in ihrem regulären Biologieunterricht sowie ihr Vorwissen zum Unterrichtsgegenstand der durchgeführten Unterrichtseinheit. Im Regressionsmodell lässt sich die


Vorwissen gilt als wesentlicher Prädiktor für erfolgreiches Lernen, kann sich allerdings nur auf das Lernen auswirken, wenn es aktiviert wird (Hasselhorn & Gold, 2017). Wenn die Schülerinnen und Schüler ihr Vorwissen in der Unterrichtseinheit nicht adäquat einsetzen konnten bzw. dieses nicht hinreichend aktiviert wurde, könnte dies eine mögliche Erklärung für den Befund zum Vorwissen darstellen. Alternativ könnte vermutet werden, dass die Varianz des Vorwissens der Schülerinnen und Schüler ($s^2=3.17$) zu gering ausfällt, um das Vorwissen als Prädiktor der Kompetenzwahrnehmung in der durchgeführten Unterrichtseinheit empirisch bestätigen zu können.

Bei genauerer Betrachtung der Operationalisierung könnte vermutet werden, dass die Förderung der Kompetenzwahrnehmung vor allem auf einzelne autonomieförderliche Maßnahmen wie die informierende Rückmeldung zurückzuführen ist. Diese Art von Rückmeldung kann nicht nur die Wahrnehmung von Autonomie sondern ebenfalls die wahrgenommene Kompetenz von Schülerinnen und Schülern fördern (vgl. Connell & Wellborn, 1991; Grolnick & Ryan, 1987; Jang et al., 2010; Reeve & Jang, 2006; Taylor & Ntoumanis, 2007). Es wird jedoch angenommen, dass die mündliche informierende Rückmeldung zum Ende der zweiten Unterrichtsstunde aufgrund ihres geringen Umfangs nicht allein für die Förderung der Kompetenzwahrnehmung im autonomieförderlichen Treatment verantwortlich ist. Wie in der Diskussion zur ersten Hypothese dargestellt wurde,

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interessenförderlicher Lernumgebungen am Beispiel des Biologieunterrichts. Lernende Schule, 77, 16--
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5.7 Manuskript VII: Prädiktoren der Kompetenzwahrnehmung von Schülerinnen und Schülern im Biologieunterricht


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6. Darstellung und Diskussion der zentralen Befunde


6.1 nicht-formaler Lernort Museum

6.1.1 Befunde nicht-formaler Lernort

Die Manuskripte I und II untersuchten die Wirkung von Förderungsmaßnahmen für die wahrgenommene Kompetenz der SuS, operationalisiert als Basisstruktur (S) und Zusatzstruktur (S+). In Untersuchung 1 wurde das Lehrerverhalten vergleichbar zum typischen, aus der Schule bekannten kontrollierenden Lehrerverhalten gehalten (vgl. Dillon et al., 2006; Griffin & Symington, 1997), wohingegen in Untersuchung 2 autonomieförderliches Lehrerverhalten zum Einsatz kam. In Manuskript I wurde das Basic Need Kompetenz variiert. In Manuskript II wurden die Basic Needs für Kompetenz und Autonomie in einem 2x2 Design variiert. In Tabelle 4 sind die diesbezüglichen Hypothesen bzw. die Forschungsfrage aufgelistet. Die Ergebnisse zu der Forschungsfrage werden im Text dargelegt und diskutiert.

Tabelle 4. Übersicht der Hypothesen und der Forschungsfrage am asL

<table>
<thead>
<tr>
<th>Manuskript</th>
<th>Hypothese/ Forschungsfrage</th>
<th>bestätigt?</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>H1 Zusatzstruktur in einem nicht-formalen Lernumfeld wirkt sich positiv auf die intrinsische Motivation der SuS im Vergleich zu Basisstruktur aus.</td>
<td>Nein</td>
</tr>
<tr>
<td></td>
<td>H2 Zusatzstruktur in einem nicht-formalen Lernumfeld wirkt sich positiv auf die intrinsische Motivation der SuS im Vergleich zu Basisstruktur aus.</td>
<td>Ja</td>
</tr>
<tr>
<td>II</td>
<td>F1 Wie beeinflussen das Lehrerverhalten während einer Exkursion zum asL, die Struktur der Ausstellung und die Interaktion zwischen Lehrerverhalten und -struktur die intrinsische Motivation der SuS?</td>
<td></td>
</tr>
</tbody>
</table>
6. Darstellung und Diskussion der zentralen Befunde
6.1 nicht-formaler Lernort Museum

6.1.1.1 Befunde Manuskript I

Die Ergebnisse der ersten Untersuchung in Manuskript I zeigten, dass die in den Vorstudien entwickelte Struktur erfolgreich angewendet werden konnte. Die Implementationskontrolle in Form des Teacher as Social Context Questionnaire (TASCQ) zeigte einen signifikanten Unterschied mit einer mittleren Effektstärke zwischen Basisstruktur (S) und Zusatzstruktur (S+), zu Gunsten der Zusatzstruktur (S+), auf. Die Operationalisierung war erfolgreich. Es zeigte sich allerdings für kontrollierendes, aus der Schule bekanntes Lehrerverhalten, keine positiven Einflüsse von Zusatzstruktur auf die motivationale Erlebensqualität der SuS. In keiner der eingesetzten Subskalen des Intrinsic Motivation Inventory (IMI) ließ sich die theoretisch vermutete positive Wirkung der Zusatzstruktur nachweisen. SuS fühlten sich nicht kompetenter, nahmen nicht mehr Wahlmöglichkeiten wahr und empfanden nicht mehr Interesse und Vergnügen. Hypothese H1 konnte nicht bestätigt werden. Die Ergebnisse aus Untersuchung 1 weisen darauf hin, dass Schulbesuche am asL, die Lehrerverhalten und Unterrichtsmethoden aus dem formalen Lernen anwendeten (Griffin, 1994; Griffin & Symington, 1997; Pelletier & Sharp, 2009), wenig Nutzen aus Struktur ziehen können. In der Forschung von Griffin (1994), Griffin und Symington (1997) sowie Pelletier und Sharp (2009) ist das typische Lehrerverhalten durch einen Methodentransfer von formalen zu nicht-formalen Methoden, aufgabenorientierten Instruktionen und direkten Anweisungen geprägt. Die potentiell von den SuS wahrgenommene Kontrolle könnte die unterstützende Wirkung der Struktur unterminiert haben (vgl. Jang et al., 2010; Sierens et al., 2009). Da keine Effekte der Zusatzstruktur auf die Motivation gefunden werden konnten, die Implementationskontrolle allerdings einen mittleren Effekt aufwies, kann davon ausgegangen werden, dass die Operationalisierung der Struktur nicht der Hauptgrund für das Fehlen einer positiven Wirkung auf die Motivation war, sondern das für die Untersuchung replizierte typische Lehrerverhalten. Es ist möglich, dass die Struktur in Form von u.a. zusätzlichen Erklärungen, Minianleitungen und einem Zeitplan nicht als strukturierend, sondern als kontrollierend empfunden wurde. Dies legt eine gewisse Abhängigkeit des Lehrerverhaltens und der Struktur nahe. Sollte das kontrollierende Lehrerverhalten den positiven Effekt der Struktur unterminieren, wie es Sierens et al. (2009) berichten, so muss neben der Struktur zur Förderung der Kompetenzwahrnehmung auch die Autonomiewahrnehmung der SuS fokussiert werden.

In Untersuchung 2 wurde autonomieförderliches an Stelle des kontrollierenden Lehrerverhaltens eingesetzt. Auch in der zweiten Untersuchung zeigte die Implementationskontrolle einen signifikanten Unterschied mit einer mittleren Effektstärke zu
6. Darstellung und Diskussion der zentralen Befunde
6.1 nicht-formaler Lernort Museum


6.1.1.2 Befunde Manuskript II

In Manuskript II wurden Autonomieförderung und Struktur am asL genauer betrachtet und in einem 2x2 Design untersucht. Lehrerverhalten (A / K) und Struktur (S / S+) wurden variiert. Auch hier waren die Implementationen erfolgreich. Es zeigten sich signifikante Interaktionen zwischen der Wirkung des Lehrerverhaltens und der Struktur auf die Motivation der SuS in den Subskalen „wahrgenommene Kompetenz“, „Druck/Anspannung“ und „Interesse/Vergnügen“ des IMI. Die signifikanten Interaktionen sprechen dafür, dass die Faktoren Lehrerverhalten und Struktur in ihrer Wirkung auf die Motivation zusammenhängen. Wie beschrieben, überschneiden sich die Effekte beider Faktoren in Bezug auf die drei Kontexte des CMoL (s. 2.6, S.41). Das Lehrerverhalten beeinflusst vermutlich die Komponenten des soziokulturellen und des persönlichen Kontextes. Struktur hingegen beeinflusst vermutlich die Komponenten des physischen und des persönlichen Kontexts. Die Befunde lassen sich in der Verknüpfung von CMoL und SBT theoretisch verorten.

### 6.1.2 Diskussion nicht-formaler Lernort


Interessen und Überzeugungen“ vorstellbar. Im Fall von Autonomie und dem soziokulturellen Kontext ist eine Verbindung über den Faktor „Vermittler außerhalb der Lerngruppe“ denkbar. Im neuen Modell sind diese Verbindungen als Doppelpfeile gekennzeichnet (s. Abb. 4).

Abbildung 4. Überarbeitetes Modell der Verknüpfung von CMoL und SBT. Weiter adaptiert nach Basten et al. (2014). Die Doppelpfeile zeigen vermutete Wechselwirkungen an


Für Besuche am asL sollte eine Lernumgebung aufgebaut werden, die sich auf alle Kontexte des CMoL bezieht, also den soziokulturellen Kontext, den physischen Kontext und den personalen Kontext. Dabei muss ein vorteilhaftes Equilibrium gefunden werden, das ermöglicht die negativen Aspekte einer neuen außerschulischen Lernumgebung auszugleichen, das aber auf der anderen Seite keine Instruktionsakkumulation z.B. in Form von reiner Aufgabenorientierung bedeutet. Die vorgelegte Arbeit zeichnet sich durch eine spezifische Ausarbeitung der Operationalisierung der Basic Needs für Autonomie und


Die Operationalisierungen von Struktur und Autonomieförderung decken nicht alle in der Literatur genannten Aspekte ab. Feedback als kompetenzunterstützende Struktur wurde in den Untersuchungen am asL nicht umgesetzt. Im Falle der Autonomieförderung wurden innere motivationale Ressourcen, wie das Vorwissen und evtl. bestehende Interessen oder Präferenzen der SuS nicht für die Operationalisierung berücksichtigt, weil die SuS den Lehramtsstudierenden bis zur Intervention unbekannt waren.

Alle SuS erhielten, unabhängig von ihren Kompetenzen, dasselbe Maß an Struktur. Im Sinne einer Binnendifferenzierung könnte hier die Unterstützung durch Struktur an den jeweiligen SuS individuell angepasst werden, sodass vermieden wird, dass SuS unterstützt werden, die es evtl. nicht benötigen. Auch hier ist die Erfassung der individuellen wahrgenommenen Neuheit notwendig, um Struktur an den SuS angepasst einsetzen zu können.
6.2 Formaler Lernort Schule

6.2.1 Befunde formaler Lernort

### Tabelle 5. Übersicht der Hypothesen und Forschungsfragen am Lernort Schule

<table>
<thead>
<tr>
<th>Manuskript</th>
<th>Hypothese/ Forschungsfragen</th>
<th>bestätigt</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>H3 Autonomiefördernder Biologieunterricht wirkt sich positiv auf die intrinsische Motivation der SuS aus.</td>
<td>Ja</td>
</tr>
<tr>
<td>V</td>
<td>F2 Gibt es Unterschiede in der Wahrnehmung von sozialer Eingebundenheit zwischen Schülern gegenüber ihren Lehrerinnen bzw. zwischen Schülerinnen gegenüber Lehrern?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F3 Kann die Pflege lebender Tiere die soziale Beziehung zwischen Schülerinnen und Lehrern bzw. Schülern und Lehrerinnen verbessern?</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>H4 Die Bereitstellung von informativem tutoriellem Feedback während des Experimentierens im Biologieunterricht fördert intrinsische Motivationsqualitäten</td>
<td>Ja</td>
</tr>
<tr>
<td>VII</td>
<td>H5 SuS, die autonomieförderlich unterrichtet werden, nehmen sich in der durchgeführten Unterrichtseinheit als kompetenter wahr als SuS, deren Lehrkraft sich kontrollierend verhält.</td>
<td>Ja</td>
</tr>
<tr>
<td></td>
<td>H6a Die Autonomiewahrnehmung der SuS in der durchgeführten Unterrichtseinheit ist ein Prädiktor ihrer Kompetenzwahrnehmung in dieser Unterrichtseinheit.</td>
<td>Ja</td>
</tr>
<tr>
<td></td>
<td>H6b Die Kompetenzwahrnehmung der SuS in ihrem regulären Biologieunterricht ist ein Prädiktor ihrer Kompetenzwahrnehmung in der durchgeführten Unterrichtseinheit.</td>
<td>Ja</td>
</tr>
<tr>
<td></td>
<td>H6c Das Vorwissen der SuS über einen Unterrichtsgegenstand ist ein Prädiktor ihrer Kompetenzwahrnehmung in der durchgeführten thematisch entsprechenden Unterrichtseinheit.</td>
<td>Nein</td>
</tr>
<tr>
<td>IV</td>
<td>H7a Autonomiegeförderte SuS eignen sich mehr Reproduktionswissen an als kontrollierend unterrichtete SuS.</td>
<td>Nein</td>
</tr>
<tr>
<td></td>
<td>H7b Autonomiegeförderte SuS eignen sich mehr konzeptuelles Wissen an als kontrollierend unterrichtete SuS.</td>
<td>Ja</td>
</tr>
<tr>
<td>VI</td>
<td>H8 Die Bereitstellung von informativem tutoriellem Feedback während des Experimentierens im Biologieunterricht unterstützt den Wissenserwerb.</td>
<td>Nein</td>
</tr>
</tbody>
</table>

#### 6.2.1.1 Befunde Manuskript III

In Manuskript III wurde die Operationalisierung des Lehrerverhaltens am formalen Lernort Schule geprüft. Die Analyse der aufgezeichneten Sprachdateien zeigte eine theoriekonforme Umsetzung der Operationalisierung des autonomieförderlichen und kontrollierenden Lehrerverhaltens. Anhand des im Vortest erhobenen Self-Regulation Questionnaire-Academic (SRQ-A) wurde der Selbstbestimmungsindex (SDI) ermittelt. Die Treatmentgruppen unterschieden sich nicht signifikant im SDI. Beide Treatmentgruppen zeigten vergleichbare

6.2.1.2 Befunde Manuskript V

problematischen Beziehungen zwischen SuS und Lehrkräften (vgl. Feldlaufer et al., 1988) durch ein positives soziales Umfeld verbessert werden (vgl. Solomon et al., 1997).


6.2.1.3 Befunde Manuskript VI


6. Darstellung und Diskussion der zentralen Befunde
6.2 Formaler Lernort Schule


6.2.1.3 Befunde Manuskript VII


6. Darstellung und Diskussion der zentralen Befunde
6.2 Formaler Lernort Schule

6.2.1.4 Befunde Manuskript IV


6.2.1.5 Befunde Manuskript VI

Zusammenhang zwischen der Bereitstellung von Feedback und dem Wissenserwerb genauer zu analysieren, sind weitere Studien erforderlich.

6.2.2 Diskussion formaler Lernort Schule


Der beobachtete Effekt der lebenden Tiere auf die soziale Eingebundenheit könnte potentiell auch losgelöst von den Tieren replizierbar sein. Das gemeinsame Arbeiten an einem Projekt, wie z.B. an einem elektrischen Gerät oder an einem Modell für den Unterricht, könnte zu ähnlichen Effekten auf die Beziehung zwischen SuS und Lehrkraft führen. Eine fehlende emotionale Konnotation könnte allerdings auch dagegen sprechen.
Kompetenzförderliche Maßnahmen in Form von informativem tutoriellen Feedback wurden in *Manuskript VI* erfolgreich operationalisiert. Damit konnten Hinweise dafür gefunden werden, dass Feedback eine stark kompetenzfördernde Wirkung entfalten kann und ebenfalls am asL zum Einsatz kommen könnte, um die Operationalisierung dort zu ergänzen und Struktur theoriekonform in seiner Gänze abzubilden. Diese Befundlage spiegelt zum einen die Wichtigkeit von Feedback wider (Hattie & Timperley, 2007), zum anderen ist sie vergleichbar zum vorliegenden Forschungsstand (vgl. Jang et al., 2010; Kirschner et al., 2006; Taylor & Ntoumanis, 2007).

Für den Wissenserwerb der SuS zeigte sich sowohl für Autonomieförderung (Manuskript IV) als auch für autonomieförderlich dargestellte Kompetenzförderung (Manuskript VI) keine positive Wirkung auf Reproduktionswissen. Für die Ergebnisse muss einschränkend gesagt werden, dass es sich um Multiple-Choice-Aufgaben handelte. Im Gegensatz zu offenen Fragen ist hierbei ein Erraten der korrekten Lösung möglich und mag dazu geführt haben, positive Effekte zu verdecken. Die fehlende positive Wirkung auf Reproduktionswissen könnte auf die Form der Aufgaben zurückzuführen sein. Im Gegensatz zu offenen Aufgaben, bei denen selbstständig schriftlich geantwortet wird, könnten im Falle der Multiple-Choice-Aufgaben günstige Motivationsqualitäten bei der Bearbeitung der Aufgaben nur eine untergeordnete Rolle spielen.


6.3 Diskussion beider Lernorte und Limitationen

Die Betrachtung der Ergebnisse beider Lernorte deutet darauf hin, dass die Unterstützung der Basic Needs sowohl am asL als auch am Lernort Schule die motivationale Erlebensqualität und den konzeptionellen Wissenserwerb der SuS positiv beeinflusst. Es wurden wiederholt Hinweise für einen engen Zusammenhang der Basic Needs Autonomie und Kompetenz untereinander gefunden. Um die genauen Wechselwirkungen zwischen den Basic Needs aufzuklären, müssen sie in Kombinationen unterschiedlicher Ausprägung untersucht werden.

Da Chen et al. (2015) aus ihrer Studie ableiten, dass der interkorrellierende Zusammenhang zwischen den Basic Needs stark genug ist, dass eine faktoranalytische Auftrennung kaum möglich zu sein scheint muss potentiell die Form der Erhebung der Basic Needs geändert werden.

Die Befunde am Lernort Schule und am asL sprechen dafür, dass die erfolgreiche Operationalisierung von Struktur und Autonomieförderung an beiden Lernorten dazu genutzt werden kann, als Maßnahmen für Lehrkräfte eingesetzt zu werden, die ihnen helfen, konstruktiv und nicht kontrollierend mit der Neuheit von Lernumgebungen umzugehen und um den Maßgaben des Referenzrahmen für NRW (QUA-LiS NRW) gerecht zu werden.


Die Untersuchungen fanden im Rahmen einer Mitmachausstellung an der Universität statt. Dabei ist der Lernort nur eine Möglichkeit für einen nicht-formalen Lernort. Das Spektrum der nicht-formalen Lernorte (s. Tab. 1, S.30) wird damit nicht abgedeckt. Insofern ist die Interpretation der Ergebnisse einzuschränken und Untersuchungen an weiteren Lernorten sollten durchgeführt werden, um die Befunde abzusichern.

Eine Überprüfung der Ergebnisse am Lernort Schule und am asL im ökologisch validen Setting des Biologieunterrichts unter Einsatz der regulären Lehrkräfte ist der nächste Schritt, um die Befunde aus dieser Arbeit zu prüfen.
7. Fazit und Ausblick


Mit der Operationalisierung der Struktur und des autonomieförderlichen Lehrerverhaltens konnten in Manuskript I und II theoretisch fundierte Möglichkeiten zur Unterstützung der Kompetenz und Autonomie der SuS am asL operationalisiert und untersucht werden. Die Befunde sprechen dafür, dass das Bereitstellen von Struktur und autonomieförderlichem Lehrerverhalten maßgeblich dazu beitragen, motivational förderliche Lernumgebungen am asL, aber auch am Lernort Schule zu gestalten.

In den Manuskripten III-VII konnte mit dem „Care“ Treatment auch eine Maßnahme zur Unterstützung der sozialen Eingebundenheit operationalisiert werden. Weiterhin wurden Hinweise dafür gefunden, dass die Operationalisierungen der Struktur und des autonomieförderlichen Lehrerverhaltens ebenfalls am Lernort Schule anwendbar sind. Es ist gerade diese Vielseitigkeit, die die beiden Maßnahmen zur Unterstützung der Basic Needs Kompetenz und Autonomie in formalen und nicht-formalen Lernorten interessant für die Lehrerbildung macht. Diesbezüglich sind Schulungen für Lehramtsstudierende im ersten Abschnitt ihrer Ausbildung zum Thema Autonomieförderung im Biologieunterrichts im Rahmen der gemeinsamen Qualitätsoffensive Lehrerbildung von Bund und Ländern aus Mitteln des Bundesministeriums für Bildung und Forschung bereits umgesetzt worden (Großmann, Fries, & Wilde, eingereicht). Darauf aufbauend wäre eine Untersuchung denkbar, die überprüft, ob Lehrkräfte das dort gelernte auch im zweiten Teil der Lehrerausbildung oder im Anschluss letztlich im Klassenraum bzw. bei Besuchen an nicht-formalen Lernorten einsetzen.

In dieser Arbeit konnten Hinweise dafür gefunden werden, dass kompetenzförderliche Maßnahmen in Form von Struktur (z.B. Orientierung, eindeutige klare Informationen, Feedback) am asL und am Lernort Schule einen wesentlichen Teil zur Förderung der Motivationsqualität der SuS beitragen.

Da die Basic Needs miteinander in starker Wechselwirkung zu stehen scheinen, erscheint es lohnenswert, auch ihre Förderung aufeinander abzustimmen und die Basic Needs bei der Gestaltung von Lernumgebungen im Biologieunterricht sowohl an nicht-formalen Lernorten als auch am Lernort Schule als essentielle Bauteile für motivational förderlichen und hochwertigen Unterricht wahrzunehmen.
8. Weitere Publikationen und Arbeiten

8.1 Tagungsbeiträge


8. Weitere Publikationen und Arbeiten
8.1 Tagungsbeiträge

Bildungswissenschaftliche und fachdidaktische Perspektiven auf Unterricht – empirische Befunde im interdisziplinären Diskurs.


8.2 Weitere Manuskripte


9. Literatur


Reeve, J. (2009). Why teachers adopt a controlling motivating style toward students and how they can become more autonomy supportive. *Educational Psychologist, 44*(3), 159-175.


9. Literatur


10. Eigenständigkeitserklärung


Bielefeld, den ______________________________